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Agricultural Enlightenment

Knowledge, Technology, and Nature, 1750–1840

PETER M. JONES

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AGRICULTURAL ENLIGHTENMENT



Frontispiece. Monument to C.-J.-A. Mathieu de Dombasle in the village of Roville (France)

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Preface

The origins of this book can be traced back to the 1980s and the attempts by scholars to refashion our understanding of the Enlightenment. Those attempts were so successful that we no longer talk of the European Enlightenment as a singular phenomenon with a coherent and subversive intellectual vision. For social, cultural, and even political historians like myself the shift from the singular to the plural and from subversive ideas to everyday practices was both refreshing and liberating. It meant that many more historical processes could now be illuminated by reference to the beliefs, attitudes, and practices that would gel to become a common European currency of the educated in the second half of the eighteenth century. The public consumption of science is a case in point. Underpinned by a very considerable expansion of the quantity of useful knowledge in circulation, it prepared the ground for the great acceleration in technological capability known in the West as the Industrial Revolution. This was the subject of a monograph that I researched and wrote in the 1990s and 2000s: *Industrial Enlightenment: Science, Technology and Culture in Birmingham and the West Midlands, 1760–1820* (Manchester University Press, 2008).

The present book returns to this theme, but from a different angle. The emphasis is now placed on the accumulation of knowledge about husbandry, and the scope of the enquiry has been widened to embrace the whole of continental Europe. In so far as there is a geographical focus to this new study the pivot is not Birmingham and the West Midlands, but Scotland and Scandinavia. It is my contention that the supply of useful agricultural knowledge increased in the eighteenth and early nineteenth centuries and that its diffusion was facilitated by the outlook, the postures, and the associational practices that we bracket together as the culture of the Enlightenment—hence the phrase ‘Agricultural Enlightenment’ which will serve both as a working hypothesis and an analytical category. This is not to say, however, that knowledge about the capacity for improvement of the rural economy automatically reached farmers, or indeed that improvement, when and where it occurred, was a direct consequence of Enlightenment knowledge inputs. Much of the book takes the form of an exploration of the process of agricultural change and growth in Europe after circa 1750 and—weighing all the variables in the balance—an attempt to explain how and why it happened.

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A special acknowledgement is owed to the individuals whose interest in the topic I was keen to explore extended to supplying me with the published and unpublished results of their own researches: Roger Bruton, Jean Cantelaube, Laurent Herment, André Holenstein, Frank James, Michael Kopsidis, Janken Myrdal, Liliane Pérez, Ulrich Pfister, Henrik Svensson, Paolo Tesschi, Sylvain Wenger, and Niels Windfeld Lund.

Of a rather different nature are the thanks due to my wife, Carolyn, who has lived with the writing up of this project and shown great forbearance as it threatened to consume the first flush of our retirement from teaching.

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Introduction

The historical importance of agriculture is easy to overlook. Although the landscapes of Europe provide a visible record of human activity over many generations, they scarcely allow us to capture the scale of the physical effort that men and women once expended on producing crops and raising animals on the farm, or the hardships they endured. At present the fraction of the working population of the European Union employed in agriculture stands at about 5 per cent, yet around the middle of the eighteenth century it could not have been less than 75 per cent.¹ In the two centuries since 1700, labour productivity in the fields and the farmyards has increased five- or six-fold thanks to the introduction of new sources of energy and new technologies.²

Europeans started to extend the area under crops in the 1750s as population growth began to be felt in the countryside and began to press against available resources. They did so by clearing land which had rarely been used for agricultural purposes within the memory of man and by converting the 'fallow'. Some fields had always to be left without food crops and in a state of rest or fallow because it was difficult to maintain the nutrient balance of the soil by any other means. As for the land clearing, it was often embarked upon with scant regard for ecological consequences and only a hazy understanding of the law of diminishing returns. Yet two and a half centuries later farmers' energies have a very different focus. Since the 1990s they have been encouraged to diminish rather than to expand the surfaces bearing crops. The grain 'mountains' and wine 'lakes' of the European Economic Community had become tangible and somewhat ironic monuments to Europe's extraordinary agricultural productivity. From the imperative of compulsory fallowing to help crops grow, farmers have shifted to the imperative of compulsory setting aside of land in order to reduce crop surpluses. Thus, in the space of some two hundred and fifty years, the history of land use in Europe has turned a full circle.

This book focuses on the first phase of the cycle. It starts with the return of Europe's economy to a profile of growth—an upward curve detectable in some quarters as early as the 1740s and nearly everywhere else by the end of the 1760s.

¹ *EU Agricultural Economics Briefs*, 8 (July 2013), 16, 3.3; Paolo Malanima, *Pre-Modern European Economy: One Thousand Years (10th–19th Centuries)* (Leiden, 2009), p. 96 and notes.

² George Grantham, 'The Growth of Labour Productivity in the Production of Wheat in the Cinq Grosses Fermes of France, 1750–1929', in Bruce M. S. Campbell and Mark Overton (eds), *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity* (Manchester, 1991), p. 340.

The book ends in the 1840s for the reason that the constraints on the production of food and industrial crops which had applied for many previous generations largely ceased to operate beyond the mid-century point. This is true whether we focus on cereal yields (new crops, chemical fertilizers), labour productivity (new technologies, mechanization), land management (farm consolidation and rural habitat reorganization), or markets (local, long-distance, and oceanic trade in grain and natural fibres). The expansion of agriculture between 1750 and 1840 can be considered a success story if only for the reason that it succeeded in feeding, for better or worse, a population growing at an accelerating rate. In the century after 1750 the population of Europe including European Russia approximately doubled.³ The increase was accompanied, moreover, by a very considerable enlargement of the stock of land brought under the plough. Despite the headlong population growth, the land supply remained elastic still in the first half of the nineteenth century. These processes were played out on a broad front and it is necessary therefore to adopt an explanatory approach which takes proper account of the common heritage of Europe's agricultural economy. Between 1750 and 1840 Agricultural Enlightenment would recognize no frontiers.

The framework which we have adopted in an effort to explain these changes puts the main emphasis on supply factors: the production and diffusion of knowledge, the transfer of skills, the role of technology and, not least, the actions of the State. As a research paradigm Agricultural Enlightenment can be viewed as the counterpart to Industrial Enlightenment inasmuch as it rests on assumptions of a similar nature and hypotheses which are drawn in the main from development economics.⁴ This is not to ignore or neglect the objections that have been raised to challenge the supply-side approach, however. They are of several sorts. Some economic historians argue that the modernization of agriculture in the decades after 1750 requires no *deus ex machina* intervention of a 'knowledge economy'. It can be explained perfectly well by reference to demography, relative prices, and the push-pull effects of expanding urban markets. Such historians, it is true, tend to place more reliance than does this author on the limited quantitative data relating to the period, and also on econometric extrapolation as a mode of enquiry.⁵

Many rural historians, on the other hand, consider agricultural change to be essentially a 'farm-gate' phenomenon. In other words, the dissemination of improved practices and technologies owed little or nothing to savant knowledge conveyed from on high. Instead, it relied on close observation and oral wisdom gleaned in

³ Malanima, *Pre-Modern European Economy*, p. 9, table 6.

⁴ See the author's *Industrial Enlightenment: Science, Technology and Culture in Birmingham and the West Midlands, 1760–1820* (Manchester, 2008, 2013) and more generally Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton, NJ, 2002) and *The Enlightened Economy: An Economic History of Britain, 1700–1850* (New Haven, CT, 2009).

⁵ On the fragility of eighteenth and early nineteenth century statistical data, note the comments of Giovanni Federico, *Feeding the World: An Economic History of Agriculture, 1800–2000* (Princeton, NJ, 2005), pp. xiii, 16, and Eric L. Jones, *Locating the Industrial Revolution: Inducement and Response* (Singapore, 2010), pp. 6–7. For a recent attempt to project back to the thirteenth century national income for Great Britain, see Stephen Broadberry, Bruce M. S. Campbell, Alexander Klein, Mark Overton, and Bas van Leeuwen, *British Economic Growth, 1270–1870* (Cambridge, 2015).

local food markets, at cattle fairs and in exchanges among neighbouring farmers. The conclusion that follows is that progress in the direction of a more enlightened and productive agriculture must have been a piecemeal process. A third approach would not raise questions about the specific mechanisms of knowledge and skill transmission, but would certainly challenge the rather narrow focus of most studies of Europe's economic trajectory. The argument that Europe's rise to a position of economic and political dominance after 1800 was partly rooted in long-term developments within the agrarian economy attracts particular criticism. According to trans-national historians the origins of the divergence between West and East is not to be found in the fields and farmyards of Europe which appear technically rather backward when compared to the sophisticated agricultural systems found in parts of China and south-east Asia by the end of the eighteenth century.

Sources are undoubtedly a problem for historians interested in agriculture—if only for the reason that eighteenth-century observers took the functioning of the rural economy largely for granted. Whilst the local market price of grain might be subject to some form of serial recording, it was generally only at times of harvest shortfall that manorial officials, provincial estates, audit courts, or central government bureaucracies thought to mount more sustained enquiries into the fortunes and well-being of those who cultivated the land. Before 1750, or thereabouts, there was no such thing as a concept of agricultural 'performance' in any case. As we show in chapter one, explicit connections linking agriculture, wealth generation, and fiscal capacity were established quite late on in the century. The normal, day-to-day operations of farmers were simply not noted down in a consistent way and they usually have to be identified and evaluated on the basis of indirect, qualitative evidence.

By the eighteenth century, it is true, we can call upon increasing numbers of travel accounts in which observations on farming and the condition of the countryside are to be found aplenty. But travellers tended to have an eye for the striking much more than for the commonplace as Ann Kussmaul has noted.⁶ What we need access to are not so much exceptional facts as typical facts, to paraphrase a remark of the Swedish agrarian historian Folke Dovring.⁷ Whilst due allowance can perhaps be made for non-specialist commentators such as Daniel Defoe whose *Tour through the Whole Island of Great Britain* (1724–27) pioneered the travelogue genre, the problem is more acute when we are dealing with accredited agricultural writers such as Arthur Young or William Marshall. Young certainly considered himself to be a conscientious and accurate chronicler of the state of agriculture whether he was touring in England, Ireland, France, or Spain, but this has not deterred historians from raising fundamental questions about the value of his testimony.⁸

⁶ Ann Kussmaul, *A General View of the Rural Economy of England, 1538–1840* (Cambridge, 1990), p. 6.

⁷ Cited in Carl-Johan Gadd, 'The Agricultural Revolution in Sweden, 1700–1870', in Janken Myrdal and Mats Morell (eds), *The Agrarian History of Sweden: 4000 BC to AD 2000* (Lund, 2011), p. 13.

⁸ For an assessment of Arthur Young and his agricultural tours, see Peter M. Jones, 'Arthur Young (1741–1820): For and Against', *English Historical Review*, 127: 528 (Oct. 2012), 1100–20.

Some countries have more, and more detailed sources than others. Scotland is comprehensively documented thanks to the parish-by-parish 'statistical' surveys launched in 1791. Agricultural record-keeping developed very early in Scandinavia, too, boosted by the fiscal and land-reform policies pursued by successive Danish and Swedish monarchs and their bureaucracies. By the time the British Parliament finally accepted the need for a nation-wide population census in 1801, Denmark was on its third. The Danish agricultural writer Gregers Begtrup incorporated data drawn from the censuses of 1769 and 1787 into his own region-by-region agricultural surveys between 1803 and 1810. They were inspired by the example of Arthur Young and the County Reports initiated by the London-based Board of Agriculture.⁹ In the case of Germany or more properly the German-speaking territories, sources are often richest at the regional and sub-regional level. Prior to unification in 1871 numerous sovereign entities maintained statistical bureaux which collected data about agriculture and agrarian conditions more generally. Thus we have incomparably detailed village-level evidence for Prussian Westphalia where well-trained public officials gathered information on farms, farm labour, livestock, and crop yields in situ between 1822 and 1835.¹⁰ In France, by contrast, information of this type tended to be collected nationally rather than regionally, and in a deliberately systematic manner only from 1837.

The value of such sources is open to criticism on several counts. Until governments were in possession of reasonably accurate estimates of population calculated over a number of decades, the actual significance of agricultural statistics remained questionable. Before 1800, indeed, gross misconceptions about the profile of population change persisted in many of the larger states of Europe. Early censuses tended to be of mediocre quality in any case. In 1821 some English census enumerators jibbed at including shepherds and graziers in the category 'employed in agriculture' on the ground that they did not actually cultivate the fields.¹¹ However, the biggest problem confronting the would-be quantifier is not so much error and omission as wilful misreporting. Country dwellers tended to assume that any request for information about their crops, flocks, draught animals, and ploughs prefigured an intention to tax. Often they were right of course. Under- or over-reporting depending on the judgement of village officials vitiated the French *Statistique Agricole* for many decades. As late as 1910 serious doubts were expressed regarding the reliability of crop surface figures collected at the departmental level.¹²

⁹ Gregers Begtrup, *Beskrivelse af Agerdyrkningens Tilstand i Danmark/Description of the Mode of Field Cultivation in Denmark*. 7 vols. (Copenhagen, 1803–1810), see Dan Ch. Christensen, 'Physiocracy—The Missing Link?' in Kerstin Sundberg, Tomas Germundsson, and Kjell Hansen (eds), *Modernisation and Tradition: European Local and Manorial Societies 1500–1900* (Lund, 2004), p. 99 and n. 44.

¹⁰ See Michael Kopsidis and Heinrich Hockmann, 'Technical Change in Westphalian Peasant Agriculture and the Rise of the Ruhr circa 1830–1880', *European Review of Economic History*, 14:2 (Aug. 2010), 237.

¹¹ Cited in Kussmaul, *A General View of the Rural Economy*, p. 4.

¹² See Georges Hottenger, *La Propriété rurale: morcellement et remembrement* (Paris and Nancy, 1914), p. 4 n. 1.

An alternative way of proceeding would be to use the numerical data only at a level of spatial aggregation which would iron out their defects. In other words to pull back from the fields and farmyards and mount an investigation rooted at least partly in abstraction and inference.¹³ But this is not a viable option for an enquiry that seeks to vindicate the notion of an Agricultural Enlightenment fuelled mainly by institutional developments, the spread of knowledge, 'know-how', and technological capability. We need to map the links connecting agricultural practices in various parts of Europe, identify the agents and vectors of change, establish the node points in the information production networks and buttress the piecemeal evidence with exploratory case studies. By its very nature this approach demands that we stay in touch with the daily routines of cereal and animal husbandry, walking the fields and pastures, and lingering at the farm-gate.

Growing doubts about the explanatory value of quantitative data in the agrarian sphere have surfaced in recent years in any case. Neither tithe series, nor seed–yield ratios have delivered the definitive answers originally promised. With so many other variables in play, not the least being the 'Malthusian' impact of increasing demographic pressure researchers remain unable to say for sure whether the European economy experienced significant growth at the per capita level in the early modern period.¹⁴ The 'battles over figures'¹⁵ fought by an earlier generation of historians no longer seems worth pursuing; instead researchers have moved the debate onto fresh territory in the hope that a better understanding of the factors producing stagnation or activity within the rural economy can be obtained by studying land use, innovation, market integration and specialization, and optimized technologies.

The idea of viewing the rural economy through the lens of the Enlightenment may appear somewhat unusual, perhaps even perverse. If it does this can only be because we have been taught to view the Enlightenment principally as an intellectual phenomenon in which *philosophes* used coruscating 'reason' to wear away the institutions and belief systems of the *ancien régime*. Yet it seems unlikely that most educated Europeans of the later eighteenth century would have shared such a view. Of course it is true that they did not make use of the term 'Enlightenment' which was coined much later. Nevertheless, when in 1760 the German writer J. H. von Justi conjured up the powerful image of 'moral and reasonable epochs, like our own'¹⁶ the debate he was contributing to was about the land and how serfdom and insecure tenancy were not only socially demeaning but inimical to agricultural growth. The literature on the rural economy and the literature on the Enlightenment may belong to different historiographies, but in the second half of the eighteenth century they were closely intertwined. For a generation which could have had no inkling of an 'industrial revolution' waiting in the wings, the capital value of land and the primacy of agriculture were self-evident truths. It followed that agricultural

¹³ For a discussion of the methodological options, see Federico, *Feeding the World*, preface.

¹⁴ Malanima, *Pre-Modern European Economy*, pp. 276–80 and tables 7, 8.

¹⁵ The phrase belongs to Gérard Béaur, *Histoire agraire de la France au XVIII^e siècle* (Paris, 2000), p. 166.

¹⁶ *The Foundations of Power and the Happiness of States* (Königsberg, 1760) cited in Edith M. Link, *The Emancipation of the Austrian Peasant, 1740–1798* (New York, 1949), p. 103.

'progress' and how to achieve it emerged as one of the key topics for discussion amongst the educated public.

It became a topic for debate for two reasons in particular. The thought of the Enlightenment generated confidence that Nature's secrets could be unlocked and adapted to man's own purposes. Not only was agriculture susceptible of improvement, it could actually be perfected with the aid of human reason and ingenuity. Second, and no less important, the Enlightenment contrived to bring about a shift in the outlook of elites. Measures to enhance the surplus-producing capacity of agriculture became an object of public policy—for savants, for landowners, for statesmen, for bureaucrats, and increasingly for monarchs as well. In fact agricultural improvement became a patriotic 'duty', indeed a moral imperative, in certain parts of Europe as we shall see. The knowledge underpinnings of this endeavour tended to shift over time of course. In the 1750s and 1760s armchair theorists compiled many an anthology of agricultural wisdom going back to Virgil's *Georgics*. But such information was of no use to practising farmers, even supposing that it was accessible to them. As a correspondent of Arthur Young would remark, this was agriculture conceived and presented as a branch of belles-lettres.¹⁷

The 'knowledge economy' which is the focus of this book comes closest to the definition offered by Joel Mokyr and proponents of new growth theory who view the role of knowledge as being, above all else, an open-ended investment in human capital. We are talking, then, of useful 'how to' knowledge which was increasingly embedded in a distinctive literary sub-genre—the agricultural treatise or manual—as the eighteenth century drew to a climax. Such books circulated widely among the educated, not least because they were speedily translated into the major European languages. Yet even these manuals carried a quasi-utopian message inasmuch as they encouraged readers to suppose that there must exist somewhere in the realm of theory-harnessed-to-experimental-practice a supremely rational 'system' of agriculture. On the other hand, the emphasis on utility enabled the sub-genre to absorb quite swiftly information drawn from the practical sciences, particularly from chemistry and mineralogy. Yet there is a danger in this knowledge-driven approach and it is one which our investigation of Agricultural Enlightenment will bear in mind. The availability at relatively low cost of knowledge and skills was only one of several variables upon which growth depended. Useful knowledge cannot alone stand proxy for agricultural progress and the temptation to argue to the contrary should be resisted.¹⁸ We should also heed the warning of historians of the countryside: knowledge 'availability' does not translate automatically into knowledge 'take-up'.

Agricultural Enlightenment is not the same as Agricultural Revolution. In some instances the production and diffusion of useful knowledge, skills, and technology did provide critical momentum for a full-scale Agricultural Revolution when allied

¹⁷ See *Annals of Agriculture*, 20 (1793), 451.

¹⁸ In this connection see Ivan T. Berend's scepticism at the claim advanced by Joel Mokyr that useful knowledge 'affected the world more than all other social and political changes taken together', *An Economic History of Nineteenth-Century Europe: Diversity and Industrialisation* (Cambridge, 2013), p. 47.

to other factors. This study incorporates two case studies which will exemplify the process: Denmark and Scotland. But elsewhere the transition to an efficient, high-yield agriculture had barely even begun in the 1840s; or else it was prolonged over many decades and was therefore scarcely perceptible as a proto-revolutionary shift. Sometimes institutional or political factors intervened to accelerate, or stymie, economic developments. Sometimes, as in the cases of Denmark and Scotland, 'enlightenment' and 'revolution' occurred in such a short space of time that they overlapped and are hard to disentangle.

Historians are now rather wary of construing changes in the rural economy as revolutionary in any case. The older view which posits England as the site of consecutive and interlocking Agricultural and Industrial Revolutions is no longer tenable. Or at least it has been so problematized as to make general statements extremely difficult to sustain.¹⁹ Ann Kussmaul has noted that 'the agricultural manuals and farming books of the seventeenth century are full of turmoil and change, while those of the consolidating eighteenth century are models of placidity'.²⁰ This points in the direction of a 'yeoman's agricultural revolution'²¹ which was mostly complete by 1730, rendering the rest of the eighteenth century a period of largely unadventurous improvement in a rural economy that was now developing a markedly regional and specialist orientation. Nevertheless, there are still grounds for supposing that an acceleration occurred in the second half of the century, both in England and on the Continent, whether we wish to link it to the diffusion of useful knowledge or the 'push-pull' effects of population growth and recovering markets, or both factors operating together. Some would point as well to decisive breakthroughs on the technological front which would alter the balance between the drivers of growth. By the 1840s technological drivers were starting to make the running with the coming of age of an applied chemistry of agriculture and the adoption of hugely important innovations such as the mechanical threshers and relatively low-cost land drains. Of course, it could equally be argued that Europe's long-awaited agricultural acceleration only really began with the 'high farming' decades of the mid-nineteenth century, by which time all of the pointers—population, prices, institutions, and technology were set to fair. Viewed as a gestational stage on the road to modernity, Agricultural Enlightenment had fulfilled its promise by this date.

But was there only one road to modernity which passed by way of the north-western extremities of Europe? Kenneth Pomeranz together with the California School of comparative global historians has challenged the notion of a *Sonderweg* with the claim that eighteenth-century Europe and Asia constituted 'a world of surprising resemblances'.²² The moment of divergence, he claims, occurred after 1800 for highly specific and largely fortuitous reasons. If this can be shown to be the case it

¹⁹ See Broadberry et al., *British Economic Growth*, p. 129.

²⁰ Kussmaul, *A General View of the Rural Economy*, p. 99.

²¹ Robert C. Allen, *Enclosure and the Yeoman* (Oxford, 1992), part 1; the refocusing exercise began with Eric Kerridge, *The Agricultural Revolution* (London, 1967).

²² Kenneth Pomeranz, *The Great Divergence: Europe, China and the Making of the Modern World Economy* (Princeton, NJ, 2000), part one, p. 29.

throws into question the elaborate genealogies that have been created to underpin a distinctively Western Agricultural Enlightenment acting as harbinger to both Agricultural and Industrial Revolutions. Although Pomeranz and the macro-comparative historians do not pay much attention to culture, the possibility that the West might well have pioneered the useful-knowledge economy is not in serious dispute. By contrast there exists a sharp disagreement over agriculture and the role of institutions. Can it be maintained that Europe's agriculture was backward in comparison with the agricultural systems in place in the coastal regions of China and southern India? Much will depend on the units chosen for the comparison and the reliability of the quantitative evidence. Nevertheless, it is undeniable that even in western Europe large areas were subject to farming practices that were not particularly 'enlightened', nor even close to being 'enlightened' at the end of the eighteenth century. No doubt the same point holds with respect to the great eastern civilizations as well. When measuring performance it is always best to compare like with like.

Whether European agriculture was particularly deficient with regard to land management and therefore less able to cope with population growth is open to debate, but it seems unlikely. Local reports of soil exhaustion and erosion as a result of felling and clearing can easily be found but they scarcely signal an agricultural economy that had reached its ecological ceiling by the start of the nineteenth century. On the contrary, the significance of Agricultural Enlightenment lies precisely in the fact that solutions were found to the problem of the fallow, the problem of seasonal unemployment, and the scourge of malnutrition—structural solutions relating to land use, but also piecemeal improvements to farming practices based on adjustments to the mix of knowledge, technology, labour, and capital. Late eighteenth-century Europe, it should not be forgotten, was also an inventive environment which offered scope for innovation and entrepreneurship, albeit scope unevenly distributed. There seems little reason, therefore, to doubt the long-held view that Europe's institutional arrangements broadly facilitated rather than hindered growth—provided always that this argument is used in combination with others. The latest research on markets, including land markets, indicates that they were highly responsive: it is gratuitous to suggest that farmland was hard to buy and sell in order to buttress a case that 'China was closer to market-driven agriculture than was most of Europe, including most of *western* Europe'.²³ As we shall see, manorial controls proved no impediment to the development of sophisticated international grain-trading networks. Europe also gave birth in the second half of the eighteenth century to the interventionist State, the single institution most directly involved in the process of agricultural growth.

Europe was not a monolith, however. If nothing else the Great Divergence debate has prompted a renewal of interest in what can be described as the internal geography of Agricultural Enlightenment. A number of scholars have drawn attention to the fact that the north-western corner of Europe evinced a growth pattern

²³ Pomeranz, *The Great Divergence*, p. 70.

that set it apart from an early date. This Little Divergence²⁴ hypothesis is chiefly designed to provide an explanation of the different speeds of industrialization *within* the European block of countries. Yet it has clear implications for the student of agriculture inasmuch as the dynamism of the North Sea area appears to have owed a great deal to the precocious development of a knowledge economy. The origins of the putative Little Divergence are not to be found in the 1800s, but several centuries earlier and in its original formulation the theory emphasized human capital formation and institutions as the principal drivers of change. According to Jan van Zanden the countries bordering the southern North Sea (primarily England, Holland, the Spanish/Austrian Netherlands, and possibly north-eastern France, but not Denmark-Norway) displayed characteristics that distinguished them from neighbouring territories as early as the fifteenth century. Whilst the rest of Europe stagnated after 1400, real wages in the North Sea area held firm, markets continued to function relatively efficiently, agriculture moved firmly in the direction of commercial production, literacy rates climbed, and an explosion of printed book publishing sharply reduced the cost of accessing useful information.

These are sweeping generalizations to be sure. They lack the forensic detail and clear-cut causal sequences required for a demonstration of Agricultural Enlightenment in action, whether in the favoured economies of the North Sea catchment or elsewhere in Europe. Yet they do provide a suggestive context and some indication of the most promising lines of enquiry, particularly if we build into the Little Divergence model the further evidence of market ‘push’ and ‘pull’ effects collected by Dutch and German scholars.

The early-modern Dutch Republic is a case in point for here agriculture was practised within a confined territory possessing excellent transportation links to urban centres of production and consumption. Accordingly, farmers tended to organize their activities primarily in response to the opportunities generated by the urban marketplace in the manner proposed by Adam Smith. Indeed, as Jan Bieleman²⁵ has shown, the allocation of land to various types of husbandry tended to obey the ‘distance from market’ measure first postulated by the Prussian agricultural economist and landowner Johann Heinrich von Thünen.²⁶ When combined with innovations in the spheres of food, fodder, and industrial crops, such specialization proved highly effective for Dutch agriculture escaped the Malthusian resources trap and comfortably accommodated a population increase of about a third between 1795 and 1850.²⁷ The impact of escalating demand from the new industrial population centres of western Prussia has also been demonstrated, albeit for a somewhat later date. From 1830, or thereabouts, Michael Kopsidis and

²⁴ The phrase comes from Jan Luiten van Zanden, *The Long Road to the Industrial Revolution: The European Economy in a Global Perspective, 1000–1800* (Leiden, 2009), part two.

²⁵ Jan Bieleman, *Five Centuries of Farming: A Short History of Dutch Agriculture, 1500–2000* (Wageningen, 2010), pp. 26–7.

²⁶ In a homogeneous agricultural system Johann H. von Thünen argued that as distance from the market town increased so land would be allocated to crops and products cheaper to transport in relation to their value.

²⁷ Bieleman, *Five Centuries of Farming*, p. 147.

Nikolaus Wolf,²⁸ find that rapid urbanization began to incentivize Westphalian agriculture, encouraging more intensive use of arable surfaces and driving up productivity. Farmers with easy access to urban markets scarcely waited upon root-and-branch land reform in order to adjust their agricultural practices, although it is true that in this region the main institutional hurdles had been cleared away during the French occupation prior to 1814.

Even though the Divergence debates are somewhat tangential to the issue of Agricultural Enlightenment, they do serve to remind us of how far the historiography on the rural economy has travelled in a generation. Thirty or forty years ago rural historians were mostly in thrall to the *Annales* School which drew much inspiration from human geography and social anthropology. Whilst fierce debates about when and where to locate the English Agricultural Revolution were being waged, research devoted to agriculture and rural society on the Continent tended to dwell on immobility as though nothing much happened in the early modern period apart from an unending cycle of growth spurts and cutbacks. Generally speaking peasant farmers were depicted as poor adapters—subsistence orientated and resistant to the pull of the marketplace. It was contended that for centuries insurmountable technological barriers had prevented harvest volumes from rising. Only in the 1840s and 1850s with the widespread availability of mineral and artificial fertilizers would Europeans finally be able to escape the cycle of low-yield agriculture and all the anxieties and hardships that surrounded it.

Some of the items on the new agenda of historiographical debate have already been signposted in this introduction, the instrumentality of institutions and markets for instance. Others have only been hinted at. Once the European farmer is identified as an individual and granted a say in his own destiny—as an independent agent of economic change—a host of questions arise which were scarcely, if ever, asked a couple of generations ago. Some of these are big questions for which we are unlikely to obtain answers, or at least answers which relate specifically to the period of Agricultural Enlightenment. Is subsistence agriculture the product of a deep-seated cultural trait or a rational response to a lack of market opportunities? What role does literacy play; do literate farmers produce more? How ought we to measure the efficiency of the institutional context within which a given agriculture is practised? Does urban dynamism unleash agricultural dynamism or vice versa? What does most to stimulate innovation: competition or cooperation? How does knowledge ‘spill-over’ into usable agrarian technologies actually take place?

There are, however, questions of a second order which specialists have examined in great detail and for which we do now have some preliminary answers. Take the question of individualized property rights. Eighteenth-century prophets of agricultural improvement considered it an article of faith that freehold property alone could sustain the burden of Agricultural Enlightenment. As Arthur Young put it, ‘the magic of PROPERTY turns sand into gold’.²⁹ Yet it is apparent, albeit on the

²⁸ Michael Kopsidis and Nikolaus Wolf, ‘Agricultural Productivity across Prussia during the Industrial Revolution: A Thünen Perspective’, *The Journal of Economic History*, 72 (2012), 634–70.

²⁹ *Arthur Young’s Travels in France during the Years 1787, 1788, 1789* (Betham-Edwards edn, London, 1900), p. 109.

basis of piecemeal evidence, that blurred ownership and even the persistence of common rights over field and fallow posed no automatic and insuperable barrier to crop specialization and productivity gain. The same point holds in respect of the manorial economy. Lords were not the less interested in agrarian capitalism just because they were feudal seigniors farming large estates with servile labour. Most contemporary agricultural theorists, not least the physiocrats (see pp. 17–20), insisted that big farms were more productive than small ones. But recent research has questioned and considerably modified the prevailing wisdom. The big versus small farm debate was not waged on the ground of economic efficiency alone as we shall see. In any case the assumption that small peasant farmers would necessarily number among the slowest to adapt and innovate does not appear to be warranted in every case.

Diffusion, whether of information (useful knowledge), 'know-how' (skill), or tools and technology, is central to Agricultural Enlightenment. Historians have devoted much energy and ingenuity to trying to work out how it actually happened. A lively debate has ensued as specialists ponder how, and how far agronomic knowledge percolated down to practising farmers and whether, for example, the gradual extension of clover and other artificial grasses in the vicinity of the great cities of western Europe was purely the product of osmosis and emulation as cultivators copied one another's trial-and-error practices, or *prima facie* evidence of an informed or 'book-farming'³⁰ approach. The question of agricultural improvement has nourished similar debates inasmuch as it is important to know who the improvers were and what motivated them. In the contested historiography of the English Agricultural Revolution, the improving landlord recurs as the enduring image, but there are plenty of other candidates for the role of driver of change in the countryside (the lesser gentry, the larger tenant farmers, the estate managers, the urban professionals, etc.). Is it safe, moreover, to tie agricultural improvement solely to the stimulus of market opportunity? In Scotland, England, Denmark, Sweden, and some of the German principalities, the 'improvement' urge metamorphosed into a veritable ideology of patriotism during the second half of the eighteenth century. In the process the reckoning of benefits as against economic costs tended to take a back seat.

Skill mobility is another current issue and one by no means confined to historiographical debates occurring in the agrarian sphere. How were 'best practice' skills and technologies disseminated across Europe? The literature on this theme has benefited hugely from the cultural approach to technology. As a result the focus is no longer on the act of innovation in isolation, but includes the socio-political context which often influenced which practices and technologies would be taken up by the putative beneficiaries and embedded in productive processes, and which would not. By the end of the eighteenth century it seems to have been fairly widely

³⁰ The term was current from the late eighteenth century and was sometimes used dismissively, see Pamela Horn, 'The Contribution of the Propagandist to Eighteenth-Century Agricultural Improvement', *The Historical Journal*, 25:2 (1982), 323 and Sally McMurry, 'Who Read Agricultural Journals? Evidence from Chenango County, New York, 1839–1865', *Agricultural History*, 63:4 (1989), 1.

grasped that the transfer of tools and machines from one location to another would not, of itself, confer an agricultural advantage. Skilled farm professionals in possession of 'know-how', not the hardware, were the key. But was it better to 'buy in' expert tenant farmers, stock raisers, shepherds, dairy workers, wheelwrights, ploughmen, and so on, or to despatch selected individuals to acquire the necessary skills in situ (in Flanders, Scotland, England)? As we shall see it was generally speaking only the larger estate owners and governments seeking the short-cut route to Agricultural Enlightenment who engaged in physical skill transfer. Sometimes the strategy worked quite well, but all too often it is only the success stories that have been recorded. In many more cases, we suspect, these rather contrived attempts to redistribute accumulated human capital petered out after a generation or so. Innovation required a sustained effort and a supportive environment for it to work.

Britain has traditionally been regarded as the main repository of useful knowledge and technological capability in the late eighteenth and the early nineteenth centuries. Sidney Pollard, the economic historian, allowed no room for doubt on this score when he chose to call his influential textbook *Peaceful Conquest: The Industrialisation of Europe*. The Industrial Revolution, he insisted, began in Britain and was exported whole to the countries of continental Europe which made no significant contribution of their own until the 1870s. As far as the Continent was concerned, then, it was 'a purely and deliberately imitative process'.³¹ Few historians would be so categorical today. On the contrary, it is the inter-connectedness of the European end of the Asia landmass which tends nowadays to be emphasized. Knowledge and technology flows were never one-way in any case and insofar as the continental states had fallen behind by 1814 the deficit would quickly be made good. If Britain had an advantage that persisted, it lay not so much in raw knowledge production as in the strength of its marketplace which took care of conversion and implementation.

Much of this analysis applies also to what we have dubbed Agricultural Enlightenment. It, too, was a joint venture with common lines of enquiry and common outcomes as our study will demonstrate. Continental visitors, it is true, never ceased to remark on the cultural specificity of the British Isles. Their travel journals, moreover, often became the repository of admiring observations on the flourishing appearance of English agriculture. J. H. G. von Justi for instance considered the difference between English and German farm practices in 1761 to be 'like light contrasted with shade'.³² But this does not mean that Agricultural Enlightenment formed part and parcel of a project which Britain handed down pre-formed to the rest of Europe. It is therefore a little frustrating that the theoretical underpinnings of the Great Divergence thesis should require Britain to be set apart from Europe once more. Britain's intercontinental trade, her early lead in the exploitation of steam power and her rapid acquisition of a colonial empire are

³¹ Sidney Pollard, *Peaceful Conquest: the Industrialization of Europe, 1760–1970* (Oxford, 1981), p. v.

³² Alison E. Martin, 'Pæns to Progress: Arthur Young's Travel Accounts in German Translation', in Stefanie Stockhorst (ed.), *Cultural Transfer through Translation: The Circulation of Enlightened Thought in Europe by Means of Translation* (Amsterdam and New York, 2010), p. 297.

highlighted in order to substantiate the contention that the divergence of the West from the East which was barely perceptible from the vantage point of 1750 had started to happen by 1800. The Industrial Revolution, having been reconceived by the current generation of economic historians as a Europe-wide phenomenon, is thus restored to its 'rightful' owner.

This book consists of eight chapters. Investigation of the phenomenon of Agricultural Enlightenment is loosely organized under thematic headings and pursued at several levels. The thematic chapters take a pan-European approach and wherever possible employ juxtaposition and comparison in order to capture the range of experiences and outcomes on the ground. Within each chapter an attempt is made to preserve a sense of chronology whilst, overall, the topics covered are tackled in the order which seems to capture best the trajectory of Agricultural Enlightenment between *c.* 1750 and 1840. Thus chapter one introduces the economic debate as it related to agriculture from the 1750s onwards, whereas chapter two switches the focus to government and the politics of agrarian reform—a subject which appeared on the agendas of European states during and after the Seven Years' War for the most part. The final chapters (seven and eight) chart the gradual eclipse of Agricultural Enlightenment as the natural sciences started to make the running, field practice became institutionalized and the chemistry laboratory and research station brought the epoch of informal knowledge diffusion to a close. The planners, meanwhile, were working towards a redesign of the agrarian landscape in a foretaste of the more *dirigiste* agricultural policies pursued by governments in the protectionist climate of the late nineteenth century. Chapters three, four, and five on the other hand are devoted to the exploration of themes: vectors and agents of knowledge transmission; innovation, emulation and diffusion; and technology circulation and transfer. Chapter six takes stock and puts some of the current debates alluded to in this introduction to the test with the aid of case-study evidence drawn principally from Denmark and Scotland.

1

Agriculture, Industry, and Commerce

The idea of agricultural progress or growth belongs, properly speaking, to the eighteenth century. Insofar as governments and the educated paid much attention to agriculture it was concentrated on the issue of the food supply and the risk of social disorder should grain stocks run low. Few Europeans were equipped with a concept of the functioning of the economy as a whole, let alone of the rural economy—discussion of such abstractions would have been discouraged in many States in any case. Yet everything started to change from the second half of the eighteenth century. New discourses emerged which focused wholly or partially on the theory and practice of husbandry: physiocracy and agronomy in France; cameralism and *Statistik* in German-speaking lands; political economy nearly everywhere. In a short space of four or five decades the output of printed literature relating to agriculture, industry, and commerce multiplied sevenfold.¹ Virtually the whole of Europe played some part in this reappraisal exercise and it helped to structure the Enlightenment with an important body of economic thought and one, moreover, which carried enormous implications for the future. In the early decades of the nineteenth century the newly minted agrarian discourses would be reconstituted as ‘sciences’, and in some instances their precepts would find their way into political programmes as well.

What had changed? It is one of the purposes of this and the following chapter to find out. The biggest of the several conceptual shifts occurring in the middle decades of the century was undoubtedly the realization that the European economy in general and the agricultural economy in particular were a source of wealth that could be permanently expanded. To a modern generation accustomed to uninterrupted or barely interrupted industrial and technological revolution, the notion of growth, whether of population, material resources, or human opportunity will scarcely seem like a revelation. It should be remembered, however, that even in Great Britain which was industrializing rapidly by the 1820s the reality of continuous growth was by no means universally acknowledged, or accepted. As for agriculture, it had been traditionally regarded as an activity practised chiefly for the purpose of producing sufficient food for people to eat, an objective which remained elusive and not infrequently unattainable even at the start of the nineteenth

¹ Christine Théré, ‘Economic Publishing and Authors, 1566–1789’, in Gilbert Faccarello (ed.), *Studies in the History of French Political Economy: From Bodin to Walras* (New York, 1998), p. 21 cited in Jay M. Smith (ed.), *The French Nobility in the Eighteenth Century: Reassessments and New Approaches* (University Park, PA, 2006), p. 22.

century. By general agreement it lay outside the realm of government prescription save in times of grave emergency. The recognition of land as an asset to be exploited and those who managed and tilled it as a definable class of diligent wealth extractors constituted a significant conceptual shift then. After 1750, or thereabouts, abstract thinking about the economy and practical thinking about the ways in which age-old agricultural practices might be improved became a Europe-wide obsession. In fact, they became a matter of State.

For many the way ahead lay in the progressive accumulation of useful knowledge. Once such knowledge had been gathered together, empirically tested and validated it could be deployed in the farmyards and in the fields—provided always that the deployment was accompanied by a thorough understanding of how the wider economy and society actually worked. Agricultural Enlightenment involved more than just a concept shift within governing elites and the elaboration of new techniques for food production; it presupposed a sustained investigation into the sources of capital and profit and the roles played by the landowner, the farmer, and the labourer in the collective task of food production and wealth generation. In other words it opened up for examination the whole question of the relationship between agriculture, industry, and commerce at a time when the familiar categories of thought and debate were ceasing to make satisfactory sense on the ground.

The formal distinction between agriculture and industry which underpins much modern economic development theory barely existed in the eighteenth century. Europeans were mentally conditioned to conceive of agriculture as an ‘industry’ much like any other potentially productive undertaking. And why not in an age largely innocent of concentrated and increasingly mechanized manufacturing activity, one in which agricultural and craft occupations reliant on human skill and animal power often took place side by side and with a significant workforce overlap? ‘Industry’ was understood as a generic term, and it followed that the institutions set up in many European states from mid-century onwards to promote improvements to the arts and crafts tended to embrace the whole spectrum of productive labour, whether undertaken in fields, in counting houses, or in artisanal garrets and workshops. Thus the London Society for the Encouragement of Arts, Manufactures and Commerce (founded in 1754) devoted a great deal of its energy and resources to the task of agricultural improvement. The same was true of the *Oekonomische Gesellschaft*, or Economic Society, of Berne (1759), the Hamburg Patriotic Society (1765), and the Paris-based *Société d’encouragement pour l’industrie nationale* (1801).

Jean-Baptiste Say who would emerge to prominence in the 1800s as a lucid and perceptive analyst of the European economy in transition summed up the umbrella category of ‘industry’ in his *Treatise on Political Economy* (1803). It could be divided into three types, he maintained: agriculture, manufacture, and commerce. Each of these types enshrined three operations: theory, application, and execution. All forms of work within this tripartite schema were to be considered as useful and productive whether undertaken by agriculturalists, industrialists, or merchants. This view marked something of a shift from mid-eighteenth-century doctrines

which accorded primacy to agriculture within the 'industry' spectrum as we shall see. Nevertheless, it helps us to understand why French writers could refer routinely to the existence of an 'industrie agricole',² and even a 'manufacture agricole'.³

Unsurprisingly, the only country where such an inclusive definition of 'industry' seems to have caused a degree of tension almost from the outset was Great Britain. In the final decades of the eighteenth century the agricultural writer Arthur Young used his position as editor of the *Annals of Agriculture* to question whether the 'landed interest' was receiving parity of treatment at the hands of government.⁴ He complained of the specious language which insisted that the needs of the commercial classes were necessarily congruent with those of landlords and farmers. Yet the suspicion that the British economy was becoming lop-sided as the manufacturers constituted themselves an independent force did not deter King George III from referring to agriculture as 'that greatest of all manufactures'.⁵

Young's anxieties were well placed if a little premature in the sense that the onset of the Napoleonic Wars (1803–15) did much to reassert the relevance and value of agriculture to the nation's well-being. But once the wars were over a real debate began which quickly exploded the older vision of a balanced organic economy. With the passing in 1815 of a fresh set of Corn Laws in a bid to protect the capital investments in arable cultivation which had been made during the long conflict with France, it swiftly became apparent that price-fixing risked pushing up wage costs and jeopardizing the profits of manufacturers.⁶ A new generation of economic theorists emerged in consequence, whose commitment to the 'industry' of agriculture as the primary wealth generator was considerably attenuated. Indeed, David Ricardo came to view landowners and factory owners as natural opponents.⁷

Across the Channel and the North Sea similar debates were starting up. They were driven in part by the all too visible evidence of capital accumulation via manufacturing industry. But a number of European states had also followed the lead of Britain in resorting to an agricultural duty system—if only in order to secure food supplies at a time of seemingly relentless population growth. Such protectionist measures served only to draw attention to the differentiation now taking place within the European economy which linguistic idioms carried over from the Enlightenment could no longer satisfactorily accommodate. In pre-unification Germany Friedrich List was one of the first to theorize the transition that was now under way and to question the logic of singling out agriculture for special

² Dominique Margairaz, *François de Neufchâteau: biographie intellectuelle* (Paris, 2005), p. 441; Paul Robin, Jean-Paul Aeschlimann, Christian Feller (eds), *Histoire et agronomie: entre ruptures et durée* (Paris, 2007), p. 39 n. 13.

³ André-J. Bourde, *Agronomie et agronomes en France au XVIII^e siècle*. 3 vols (Paris, 1967), iii, p. 1315.

⁴ *Annals of Agriculture, and other useful Arts collected and published by Arthur Young Esq FRS*, 10 (1788), 402–3; 20 (1793), 204.

⁵ Susanna Wade-Martins, 'The English Model Farm 1700–1900: Significance and Context', *Journal of the Historic Farm Buildings Group*, 11 (1997), 21.

⁶ See Jeffrey G. Williamson, 'The Impact of the Corn Laws just prior to Repeal', *Explorations in Economic History*, 27 (1990), 123–56.

⁷ David Ricardo, *Principles of Political Economy, and Taxation*, 3rd edn. (London, 1821), p. 399.

treatment.⁸ The 'free-trade' lobby of the north Netherlands merchants shared this outlook. Following the dearth of 1816–17 it succeeded in persuading King William I to attenuate restrictions on cereal imports, with the result that the efficient food producers of Belgian Flanders found themselves unable for a time to compete against shipments from the Baltic and even from the Ukraine.⁹ In France, meanwhile, Jean-Baptiste Say's thinking was also evolving—prompted no doubt by the commission he received in 1815 from the Bourbon Restoration government to investigate afresh the sources of Great Britain's extraordinary growth. A vigorous polemic ensued which pitted the partisans of agricultural primacy against ministers and their advisors who viewed the rural economy as incorrigibly resistant to change. They sought instead to advance along the pathway to modernity which the English were blazing. It is true that the defenders of agriculture were mostly drawn from an older generation whose intellectual moorings tied them inextricably to physiocracy and its agrarian derivatives.¹⁰ Such individuals belonged to the eighteenth century and they found it difficult to accept the evidence that manufacturing industry could be genuinely productive and might therefore represent a separate and independent source of capital accumulation.

PHYSIOCRACY

The most sophisticated attempt to theorize the eighteenth-century economy emanated from a coterie of French agrarian philosophers known to contemporaries as *économistes*. These individuals congregated around François Quesnay, court physician to Louis XV, and the Marquis de Mirabeau in the late 1750s and early 1760s. They were subsequently joined by a number of other thinkers including Pierre-Samuel Dupont who coined the term 'physiocracy'—meaning the rule or reign of nature. The physiocrats would mount a sweeping critique of mercantilist trade policies, focusing particularly on intervention to stimulate manufacturing activity which was practised by governments throughout Europe. However, their insistence that agriculture be treated as the sole source of national wealth would be undermined in turn by the advent of large-scale industrialization and the reconfiguration of the economy and society that followed in its wake.

Although the immediate impact of the physiocrats was slight, whether in France or elsewhere in Europe, the central thrust of their thought was taken up by the partisans of political economy whose influence proved far more pervasive and enduring. When Maximilien de Lazowski came to Suffolk in order to visit Arthur Young in 1785 the closely reasoned analysis of the foundations of England's

⁸ William O. Henderson, *Friedrich List: Economist and Visionary, 1789–1846* (London, 1983), pp. 158–63.

⁹ Charles Terlinden, 'La Politique économique de Guillaume I^{er}, Roi des Pays-Bas en Belgique, 1814–1830', *Revue historique*, 89 (1922), 32–3.

¹⁰ For a representative of this point of view, see Baron Jean-Baptiste Rougier de la Bergerie, *Considérations générales sur l'histoire, servant d'introduction à l'histoire de l'agriculture ancienne et moderne en Europe* (Paris, 1829).

prosperity which he would subsequently submit to French government ministers carried the unmistakable imprint of the *économistes*. It is 'a truth beyond dispute', he asserted, that this country 'owes its commerce and everything else solely to agriculture'. Lest the point missed its mark, he repeated the claim that England's high-yield agriculture nourished both its commerce and its industry, 'and for this reason should be considered the one and only true cause of its wealth'.¹¹ Young repaid the compliment with a tour of inspection of France two years later. Whilst unable to find much evidence of a flourishing system of agriculture across the Channel, his diagnosis of the wealth of nations rested on foundations that were essentially the same.

Was this contemporary judgement so unreasonable? After all it has been estimated that in the decade when Lazowski, Young, and many others were groping their way towards an understanding of the workings of the economy only 20 per cent of England's physical output consisted of industrial products unconnected to agriculture or animal husbandry.¹² In other words, much of manufacturing industry involved the processing of raw materials derived from planted crops, from domestic animals, or from the forests. Baron Rougier de la Bergerie made a similar point for France when criticizing the tunnel vision of Restoration parliamentarians on the subject of 'l'industrie manufacturière' (in 1827 they had voted to separate commerce from agriculture and river management from forests). Agriculture (cereals, wine, wool, etc.), he observed, supplied 60 per cent of the nation's stock-in-trade.¹³

The physiocrats' analysis of the functioning of the economy was almost entirely theoretical and it is for this reason they have been regarded as the founding fathers of the modern science of economics. Only in the later 1760s and 1770s, as their adherents began to make common cause with those urging a more laissez-faire approach, did physiocracy acquire a specific programme which governments were urged to implement. In his *Tableau économique* (1758–59) Quesnay constructed a model of the entire production process in which the capital stock underpinning the market circulated by virtue of natural mechanisms quite independently of man-made arrangements. Whilst the role of landlords and other possessors of agrarian capital such as tithe and seigniorial dues beneficiaries was highlighted, the truly productive class, in his view, consisted of the big farmers who rented the land in large blocks and hired the labour to till it efficiently. These agricultural entrepreneurs and they alone, were capable of adding to the circulating capital by generating a surplus (known as the *produit net*, or profit once production costs had been deducted). By contrast, those engaged in economic activity outside agriculture were considered to constitute a 'sterile' class because all they were doing was to add value

¹¹ Archives Départementales [henceforth A. D.] de l'Oise, Beauvais 6Jp 14 'Etat de l'agriculture en Angleterre. Comparaison de son agriculture avec celle du royaume de France; causes de son avancement, moyen d'amener une révolution dans la culture en France', 86 folios.

¹² D. W. Jones, 'The Workings and Measurement of Pre-Industrial "Organic" Economies: Conjectures on English Agrarian Growth, 1660–1820', *The Journal of European Economic History*, 35:1 (2006), 182.

¹³ Rougier de la Bergerie, *Considérations générales sur l'histoire*, pp. 140–2.

to raw materials brought into being by the capital input and entrepreneurship of the productive class.

The agricultural economy can be considered the foundation and source of the wealth of nations, then. It *is* the economy and should be left to function in accordance with the 'laws of nature'. The obvious objection to this scenario resides in the *économistes*' refusal to allow the possibility that inland trade and overseas commerce might constitute an independent source of profit. Or that labour rather than land was the true source of productivity as the writer J.-J.-L. Graslin had observed.¹⁴ Less obviously, they also failed to acknowledge the capacity of manufacturing industry to accumulate capital and generate surpluses that in origin owed little or nothing to land rent.

By the 1770s Adam Smith and others were in a strong position to point this out. But physiocracy as a pure doctrine preaching the primacy of agriculture to the exclusion of all other sources of revenue had passed its peak by this date. Whilst saluting the *économistes* for their apparent success in persuading governments and public opinion to dwell at long last on the needs of the rural economy, Smith allocated a chapter of *Wealth of Nations* (1776) to the 'Agricultural System', the gist of which was to distinguish his views from both mercantilists *and* physiocrats. The former were condemned as neo-Colbertian regulators who erred in attaching too much economic weight to urban handicrafts, whereas the latter were held to account for failing to appreciate the web of interdependence connecting the agricultural and the manufacturing spheres. The assertion that artisans and manufacturers added no new value was misplaced inasmuch as their labour contributed to the total wealth of society. Indeed, commerce and manufacturing activity helped to pay for additional human subsistence that agriculture on its own could not always be relied on to provide. It is true, as Istvan Hont¹⁵ has pointed out, that Smith substantially re-conceived the relationship between town and country: instead of an efficient surplus-producing agriculture supporting an expanding urban population, he envisaged the lead role in the growth trajectory being taken by urban manufacturing. The output of finished goods from factories and workshops would trigger demand in the countryside which could only be satisfied by trading agricultural surpluses in exchange.¹⁶

The pure theory of physiocracy was scarcely ever acted on. In the second half of the eighteenth century rulers and governments took note of the intellectual argument for focusing attention on the economy—after all it reinforced more immediate concerns as we shall see in chapter two. But they responded pragmatically and generally speaking avoided taking up a firm position in the debates of the 1760s and 1770s. Only in southern Germany did a serious-minded attempt to apply the principles of physiocracy to the small principality of Baden-Durlach occur. The Margrave, Carl-Friedrich, began a correspondence with Mirabeau on the subject of how to calculate the *produit net*, and in 1770 he went ahead and

¹⁴ Alain Becchia, *Modernités de l'Ancien Régime, 1750–1789* (Rennes, 2012), p. 65.

¹⁵ Istvan Hont, *Jealousy of Trade: International Competition and the Nation-State in Historical Perspective* (Cambridge, MA, 2005), pp. 413–14.

¹⁶ Adam Smith, *An Enquiry into the Nature and Causes of the Wealth of Nations*, book 4, chapter 9, paragraphs 48–9.

established the single tax on land in three villages of his duchy. Danish reformers also pressed the case for physiocracy on the Crown Prince who would eventually accede in 1766 as Christian VII. However, specialists are not in agreement as to whether much physiocratic influence can be detected in the agrarian reforms that were just beginning to take shape (see pp. 148–54), particularly as there were strong currents of agrarian philosophy of a more utilitarian character reaching Scandinavia from England.¹⁷ One of the problems with physiocracy, as with all economic discourses which turned the spotlight on agriculture is that they tended to illuminate unpalatable socio-political issues in their beam. The doctrine had made converts among Neapolitan and Spanish economists as well, but it soon became evident that little progress could be made unless feudalism and the opacity of property rights in the Bourbon kingdoms of Naples and Spain were also tackled.¹⁸

CAMERALISM

Although physiocracy penetrated the German-speaking lands in its more diluted form in the late 1760s and 1770s, it encountered native traditions of economic thought which focused chiefly on household or estate management (*Hausväterliteratur*). This was economics adapted from its original meaning of a ‘doctrine of the household’ as defined by Aristotle.¹⁹ Literature catering for the household style of thinking had been around since the sixteenth century. It had little to say about commerce, or the trade in agricultural products since it was targeted principally at aristocratic owners of estates and pre-supposed a large measure of autonomy and self-sufficiency. The advice offered in such publications tended to consist of miscellaneous scraps of social, ethical, and technical information set in a pre-industrial and patriarchal framework. The agricultural estate was viewed as a gift which the landowner held on trust from God. Not until the 1800s would such writings succumb to the conception of agriculture as an enterprise, a viewpoint defended in the German territories by Albrecht Daniel Thaer (see p. 52). Thaer drew his inspiration not from native traditions or from physiocracy, but from the writings of Adam Smith and Arthur Young.

Cameralism or *Kameralwissenschaft* in its eighteenth-century formulation was another endogenous school of thought with an economic thrust which developed

¹⁷ See Dan Ch. Christensen, ‘Physiocracy: The Missing Link?’ in Sundberg, Germundsson, and Hansen (eds), *Modernisation and Tradition: European Local and Manorial Societies, 1500–1900*, pp. 78–102; J. Engelhardt, ‘Patriotic Societies and Royal Imperial Reforms in Denmark, 1761–1814’, in Koen Stapelbroek and Jani Marjanen (eds), *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America* (London, 2012), p. 227 and n. 35.

¹⁸ John Robertson, *The Case for the Enlightenment: Scotland and Naples, 1680–1760* (Cambridge, 2005), p. 383; Anna M. Rao, ‘The Feudal Question, Judicial Systems and the Enlightenment’, in Girolamo Imbruglia (ed.), *Naples in the Eighteenth Century: The Birth and Death of a Nation-State* (Cambridge, 2000), pp. 95–117. For Spain see Richard Herr, *Rural Change and Royal Finances in Spain at the End of the Old Regime* (University of California Press, Berkeley and Los Angeles, 1989), pp. 33–7.

¹⁹ See Keith Tribe, *The Economy of the World: Language, History, and Economics* (Oxford Studies in the History of Economics, Oxford, 2015), chapter two ‘The Word: Economy’.

initially in response to the perceived need of early-modern rulers for greater access to administrative expertise. Some researchers find its origins in a university curriculum 'science', and it is true that academic chairs in state administration were established first in the Prussian universities early on in the century. Others, however, would lay greater stress on the cameralists' bid to improve the day-to-day practice of management and decision-taking via the compilation of a body of knowledge for the use of would-be bureaucrats. Such knowledge was fairly eclectic and unsystematic by the standards of physiocracy inasmuch as it embraced matter relating to the natural sciences (particularly chemistry and mineralogy) as well as the rural economy. This fact has led one scholar to question whether cameralism ever had a core substance. Was it anything more than a far-flung propaganda project involving careerist authors, fashionable universities seeking to attract students, and rulers only too keen to provide patronage in hopes of burnishing their Enlightenment credentials?²⁰

Whilst such an interpretation seems plausible, if only because an element of self-promotion can be found in all the schools of thought claiming to have laid bare the interlocking mechanisms of the economy, it diminishes the real impact of cameralism in central Europe and Scandinavia where rulers were very well aware by the second half of the eighteenth century that the sinews of their power depended heavily on the efficient exploitation of all natural resources, whether cultivable land surfaces, sub-soil minerals, or the forested environment. For all their posturing and sneering at rival philosophies the cameralists did try to teach rulers how to do this in a rational and methodical manner.

Unlike the physiocrats or for that matter those political economists cast in the mould of Adam Smith, the cameralists retained a mercantilist outlook and one which made no formal distinction between agriculture and urban manufacturing, or indeed between extractive industry and forestry. If we treat them as practitioners as seems proper, they emerged first and foremost as agents of improvement aiming to bring system and rationality to bear on the multiple activities taking place in both the rural and the urban craft economies. In the 1760s and early 1770s a large number of economic societies dedicated to the common good (*gemeinnützige Gesellschaften*) were established in the German-speaking lands (see pp. 69–70) and it is probable that most came into being under the intellectual banner of cameralism rather than physiocracy. The older tradition of household *Oekonomie* was now starting to retreat in the face of startling advances in human knowledge production, and the association or 'society' model appeared to offer a forum in which public-spirited individuals could organize concrete ways of applying the new knowledge in whichever arena appeared most relevant.

The Physical, Economic and Beekeeping Society established in the small town of Lautern (nowadays Kaiserslautern) in one of the poorer parts of the Palatinate will serve as an example. Founded in 1770, it sought to stimulate the zeal of the local farmers with incentives and the award of prizes in return for the adoption of

²⁰ See Andrew Wakefield, *The Disordered Police State: German Cameralism as Science and Practice* (Chicago, 2009).

‘enlightened’ cultivation practices. It even acquired an estate in order to trial and demonstrate the principles of best-practice agriculture. However, when this model farm began to run into difficulties of a practical nature, the approach switched to the less challenging task of training officials competent in every branch of economic management. The Cameral Institute or High School of Lautern proved a resounding success and would be widely imitated. The Elector Palatine granted it official recognition in 1777, notwithstanding some princely displeasure at the fact that the Institute tended to attract more trainees from other German states than from his own territories.

The moving force behind the developments at Lautern was Friedrich Medicus (1736–1808), a physician from Mannheim with an enthusiasm for botany who is sometimes mistaken for a physiocrat. But Medicus’s interest in agriculture always formed part of a much wider vision of the economic system. He did not prioritize the needs of agriculture; in fact he guided the Lautern Society towards the establishment of a manufactory and a workhouse as well. As André Wakefield²¹ points out, the Lautern experiment ultimately found its *raison d’être* not in agricultural improvement which proved far harder to achieve than anyone had imagined but in the production of cadres equipped to rescue the Palatinate’s factories, mines, and rural estates from routine and slack management. The speculations of Adam Smith or the French *économistes*—even in an attenuated form—were not considered relevant to this exercise. Ultimately, therefore, it was the institution of the *Kammer*, in other words the near-perennial needs of the state treasury, that exerted the most powerful influence on the cameralists’ approach to the economy, not philosophy.

Whether cameralism can be neatly resolved into a science of fiscal propaganda is another matter though.²² Insofar as it influenced the outlook of the patriotic societies which sprang up all over northern Germany from the 1760s, there seems little reason to doubt that it provided the intellectual underpinning for a quite genuine mission to promote the common good by purging habit and time-serving from every branch of the economy. Yet this enterprise gradually changed its character in the 1780s and 1790s—that is to say even before the jolt administered to the German lands by the French Revolution and the Napoleonic conquest. As we have noted in the case of the Lautern society, affiliates began to weary of economic activism that consistently failed to produce encouraging results on the ground. Instead, they switched their attention to the collecting and storing of economic knowledge. Such knowledge could then be rationalized and systematized for administrative use in the manner pioneered by Johann Beckmann²³ at the fashionable University of Göttingen (see pp. 109–11). A largely passive activity, this systematization process enabled the cameralists to claim by the end of the eighteenth century, with some justification, that they had indeed constructed an economic science, or rather a series of discrete sciences of agriculture, forestry, technology, and mineral extraction.

²¹ Wakefield, *The Disordered Police State*, pp. 123, 133.

²² Wakefield, *The Disordered Police State*, pp. 9, 11, 142.

²³ Inspired by the taxonomic work of Linnaeus, Beckmann proceeded to organize craft or trade knowledge in a similar manner and dubbed the result a ‘science’ of *Technologie* for the use of administrators, see Johann Beckmann, *Anleitung zur Technologie* [...] (Göttingen, 1777).

The repackaging of the vast quantities of agricultural information adumbrated during the eighteenth century into a quasi-scientific format owed a good deal to the discipline of *Statistik*. The German noun betrays the origins of this practice of data presentation and analysis and since the use of the term and the activity it describes can be traced back to the middle decades of the century the link to cameralism and the projection of State power seems patent. Statistics enabled statesmen and their officials to compare in a rigorously empirical fashion the resources of different countries under a number of headings: size, frontiers, population, religion, agriculture, commerce, military strength, and so on. The work of comparison was largely based on qualitative data and in consequence the analytical potential of eighteenth-century statistics remained rather modest. Only in the 1820s would the discipline develop into a full-blown mathematical science. Before that date very few European states could claim to be in possession of well-founded quantitative information. In liberal German milieux anonymous numbers smacked of authoritarianism in any case. During the Napoleonic occupation of Hannover Göttingen's history professor, A. H. L. Heeren, observed 'there are no columns for national spirit, love of freedom, the genius and character of great or small men at the top'.²⁴ Tabulation, whether of qualitative or quantitative data, was essentially a tool of State like any other, then.

Nevertheless, the statistical presentation of social and economic information (with or without columns) became hugely fashionable in intellectual circles around the turn of the century and would be widely adopted across Europe. Great Britain already had a long tradition of 'political arithmetic' of course, which can be traced back to William Petty in the 1660s. By the time of Adam Smith and Arthur Young, though, its mercantilist connotations were proving rather constricting and the continental model of *Statistik* became available at an opportune moment. The German geographer and traveller, E. A. W. Zimmermann appears to have launched the genre in the English language with his *Political Survey of the Present State of Europe in Sixteen Tables [...]* published in 1787. When, in 1791, Sir John Sinclair commissioned the first of twenty-one volumes surveying the agriculture and industry of Scotland on a parish-by-parish basis, he entitled the undertaking a *Statistical Account of Scotland*. Zimmermann's publication seems to have been the source of his inspiration, although Sinclair was at pains to emphasize that the Statist thrust of the German discipline of *Statistik* was not his primary motivation.²⁵ A little later he dubbed the new mode of enquiry 'statistical philosophy'.²⁶

The French took up the approach to social and economic enquiry with even more enthusiasm than the British. They showed an immediate interest in the innovative attempts of William Playfair²⁷ to move from tabulation to the graphic presentation of data, although the hiatus of the Revolution delayed for about a decade any real

²⁴ David F. Lindenfeld, *The Practical Imagination: The German Sciences of State in the Nineteenth Century* (Chicago and London, 1997), p. 84.

²⁵ Ted M. Porter, *The Rise of Statistical Thinking, 1820–1900* (Princeton, NJ, 1986), p. 24.

²⁶ *Memoirs of the Life and Works of [...] Sir John Sinclair bart*, 2 vols. (London, 1837), ii, p. 398.

²⁷ William Playfair, *The Commercial and Political Atlas, representing, by means of stained Copper-Plate Charts, the Exports, Imports and general Trade of England; at a single View* (various editions, 1786–1801).

progress towards the definition of *Statistique* as an independent social science. Playfair's work was reintroduced to France—in translation²⁸—during the Peace of Amiens, a favourable moment because the newly established Napoleonic regime set great store by statistics. In fact, it embarked on a massive data collection exercise in which the collation of information relating to agriculture and the rural economy featured prominently. The exercise was managed by the Ministry of the Interior and the newly installed prefects who were called upon to organize the compilation of statistical accounts for each of the departments under their jurisdiction.

This initiative was followed by the launch of a nation-wide agricultural enquiry in 1814. Louis Becquey, the administrator in charge of the operation, debated whether to insist on a rigidly quantitative reporting mode but in the end he opted for the more traditional thematic arrangement organized into a question-and-answer format. Sir John Sinclair who had headed the London Board of Agriculture and Internal Improvement and who shared Arthur Young's misgivings about the real extent of political support in Britain for agriculture was mightily impressed by these developments. He was intending to embark on an agricultural tour of France when the peace broke down in 1803. Instead, he contented himself with a correspondence with the Comte de Chaptal, Minister of the Interior, about the 'new field of statistical information'.²⁹ Sinclair would live just long enough to watch another Minister of the Interior, Adolphe Thiers, put in place the first comprehensive *Statistique Générale* of France in 1833.

POLITICAL ECONOMY

The political implications of the discovery by Europeans that the economy could be managed in order to bring about growth will by now be evident. Adam Smith memorably described the theories of the physiocrats as a branch of 'what is properly called Political Oeconomy, or of the nature and causes of the wealth of nations'.³⁰ The *abbé* Morellet³¹ in offering to the public an updated dictionary of commerce in 1769 had also come to the conclusion that the recent advances in economic understanding were such that the 'science' of political economy was ready to take wing. He was referring particularly to the way in which apparently miscellaneous facts, once gathered together, appeared to form a critical mass with the potential to disclose general causes.³² Not everyone agreed of course. Where

²⁸ Denis-François Donnant, *Eléments de statistique où l'on démontre, d'après un principe entièrement neuf les ressources de chaque Royaume, Etat et République* (Paris, 1801–02).

²⁹ *The Correspondence of the Right Honourable Sir John Sinclair Bart*, 2 vols. (London, 1831), ii, pp. 116–17.

³⁰ Smith, *Wealth of Nations*, book 4, chapter 9.

³¹ 'La science de l'économie politique paroît être arrivée de nos jours à cette époque de ses progrès', André Morellet *Prospectus d'un nouveau dictionnaire de commerce* [...] en cinq volumes in-folio proposés par Souscription (Paris, 1769), p. 2.

³² 'Une loi agronomique tient à une loi de finance; celle-ci influe sur l'industrie, l'état d'industrie sur l'agriculture elle-même, sur la navigation, sur la population etc.' Morellet *Prospectus d'un nouveau dictionnaire de commerce*.

some found meaning in a welter of facts, others despaired of political economy ever approaching a state of scientific maturity. The French chemist Jean-Baptiste Meusnier told Sir James Hall during a visit to Paris in 1791 that political economy would never manage to progress until algebra was introduced to it.³³

However revealing of the approach to knowledge of France's prestigious Academy of Sciences, this judgement must have seemed rather eccentric. In 1798 John Symonds, Regius Professor of Modern History at Cambridge, informed his friend and neighbour Arthur Young that he was preparing a new set of lectures on political economy, the content of which would embrace 'agriculture, foreign & inland trade, manufactures, taxation, prohibitions, coin, money, exchange etc. etc.'³⁴ The *et ceteras* are revealing. They implied some doubt as to where the boundaries of his subject really lay. For Young, however, the problem lay much deeper: 'of all the branches of human knowledge, I know not any that rests upon more uncertain foundations than that of political economy. True science is founded only on experiment'.³⁵

Once industrial society had started to take on visible shape in the early decades of the nineteenth century hand-in-hand with a more theoretical economics capable of explaining the development, these doubts would be allayed. But in the meantime educated Europeans made use of the language of political economy whilst remaining not altogether sure what it meant or where it was leading. Intellectual historians, too, have found uses for the rhetoric of political economy. Older historiographical certainties about the ideological content of the Enlightenment having been discarded, they have regrouped around the argument that the Enlightenment did, after all, have a common core. In the discourse of political economy they find a thread connecting territories as diverse as Scotland, Austrian Lombardy and the Kingdom of Naples.³⁶ There is much to be said for this approach which helps to reinstate the Enlightenment as a cultural phenomenon experienced at a certain social level all over Europe. However, it is important not to overstate the coherence of the ideas bundled together under the heading of political economy in the second half of the eighteenth century. They scarcely offered a systematic explanation of economic behaviour. What they did generate, though, was a new social vocabulary enabling those Europeans who wished to do so to 'think big'; in other words, to conceptualize larger social and economic entities than had hitherto been the practice.³⁷ That, and the confidence to tackle the issue of human betterment in the here-and-now world.

Human well-being was increasingly being understood in material and secular terms. In the minds of political economists, therefore, the relevant question to ask

³³ John A. Chaldecott, 'Scientific Activities in Paris in 1791: Evidence from the Diaries of Sir James Hall for 1791, and other Contemporary Records', *Annals of Science*, 24:1 (1968), 33.

³⁴ British Library [henceforth B. L.], London Add MSS W35128 J. Symonds to A. Young, 8 June [1798], St-Edmund's Hill.

³⁵ *Annals of Agriculture*, 4 (1785), 16.

³⁶ Robertson, *The Case for the Enlightenment*; Sophus A. Reinert, 'Patriotism, Cosmopolitanism and Political Economy in the *Accademia dei pugni* in Austrian Lombardy, 1760–1780', in Stapelbroek and Marjanen (eds), *The Rise of Economic Societies*, pp. 130–56.

³⁷ John Shovlin, 'Political Economy and the French Nobility, 1750–1789', in Smith (ed.), *The French Nobility*, pp. 112–13.

concerned the origins of wealth and poverty. Why were some states more wealthy and some more backward than others? Answering the question necessarily involved a consideration of the rural economy—the locus of daily existence for the great mass of the population—and agriculture. Agriculture predated both commerce and industry, however defined, and it seems unlikely that more than a handful of Europeans would have had any apprehension of an impending industrial revolution before the turn of the century. Agriculture was the inescapable element in the growth equation, then. We have seen as much in Maximilien de Lazowski's trenchant first-hand analysis of Britain's remarkably resilient and prosperous economy in the aftermath of the American Independence War. Both Lazowski and Adam Smith were political economists who had moved well beyond the physiocrats' insistence on agriculture as the sole source of wealth. Indeed, Lazowski included in his explanation a survey of institutions which drew attention to the strengths of English civil law, the absence of fiscal privilege, and the relative ease with which rural landholdings could be consolidated and enclosed (see pp. 136–9).

Arthur Young whose myriad activities we will encounter repeatedly in the course of this study was not very different in outlook. During the 1780s his stance as Europe's best-known agricultural commentator became increasingly laissez-faire, probably as a result of reading Smith's *Wealth of Nations* during a residence in Ireland between 1776 and 1778. However, this did not prevent him from defending protectionist measures when farmers' interests were at stake. His credentials as a political economist were really established in 1792 with the publication of the celebrated tours of France. He made his intentions clear almost from the outset remarking in a letter to his daughter that, 'to be the first and only one who ever did examine on the spot the culture, wealth & resources of so vast a Kingdom is an object that will I hope carry me thro' all fatigues'.³⁸ When the book eventually appeared, the *Monthly Review* remarked with some surprise that it read more like a work of political economy than a work of agriculture. It was in fact both. Despite his claim, Young was scarcely the first Englishman to map out the genre of comparative political economy and he would not be the last.³⁹ Nevertheless, his book was quickly translated and widely admired throughout Europe, casting all others into the shade. By contrast Lazowski's own travel account and subsequent report which are just as revealing ended up gathering dust in the archives.⁴⁰

Although political economy still had some way to run in Great Britain before it was taken over and revamped by the post-Smithian generation of economists, events took a rather different turn on the Continent. The outbreak of revolution in France in 1789 was hailed by every advocate of structural economic reform as an unprecedented opportunity for a new start. Would the seemingly all-powerful

³⁸ B. L. Add MSS 35126 A. Young to M. Young, Cherbourg, 27 August 1788.

³⁹ See for example, Joseph Marshall, *Travels through France and Spain, in the years 1770 and 1771. In which is particularly minuted, the present state of those countries, respecting the agriculture, population, manufactures, commerce, the arts, and useful undertakings* (London, 1776).

⁴⁰ See B. L. Add. MSS 42095 for a fragment of his letter-book and for the report see A. D. Oise 6Jp 14; also Norman Scarfe, *Innocent Espionage: The La Rochefoucauld Brothers' Tour of England in 1785* (Woodbridge, 1995), pp. 4, 6, 8, 185, 189, and *To the Highlands in 1786: The Inquisitive Journey of a Young French Aristocrat* (Woodbridge, 2001), p. 246.

National Assembly of France set an example to the rest of Europe by abolishing excise duties and concentrating public taxation on land; would it remove mercantilist controls over trade and industry; would it establish institutions which curtailed the power of vested interests? Above all, would it 'free' agriculture (from the tithe, from feudal dues, and from the multiple servitudes enshrined in collective rights)? Pierre-Samuel Dupont who was now the Third Estate deputy for Nemours and an important personage in the Assembly rather jumped the gun by writing to the editor of the *Annals of Agriculture* in order to glory in the rapid progress that his country was now making towards the implementation of the physiocrat project. England, by comparison, was being left behind. He poked fun at a nation which made a virtue of liberty and laissez-faire whilst rigorously enforcing trade restrictions and monopolies: 'every corpse in England must be buried in a new woollen shroud', he declared in mock disbelief.⁴¹ Young managed to confine his indignation at this unwarranted assault to a footnote which politely acknowledged Dupont's interpretation of England's political economy whilst declaring that he was 'misinformed & subject to errors of opinion'.⁴²

Nevertheless Young would initially signal his support for the revolutionaries as far as their economic thinking was concerned. The account of his travels in France reached the printer only after some delay and he used the interval to add topical postscripts containing a running commentary on the work of the Assemblies. The clear determination to tackle the burdens weighing down the wealth-generating sector was applauded (abolition of the tithe, abolition of the game laws, provision for the monetary redemption of seigniorial harvest dues, etc.). However, he acknowledged the difficulty legislators faced in attempting to design a taxation regime which targeted solely the disposable surplus of agriculture: 'by pursuing the jargon of the *produit net*, and making it variable, instead of fixed', he noted, 'every species of inconvenience and uncertainty has arisen'.⁴³ This was early in 1792, by which time Young had largely abandoned the illusion of a viable form of political economy constructed on a foundation of physiocracy.⁴⁴ He was no less disappointed at the failure of the revolutionaries to make good their promise to liberalize the rural economy by decreeing out of existence commons and common rights and requiring the enclosure and consolidation of farmland. Whilst smallholders seem to have profited from the Revolution, he concluded, 'I see no benefits flowing *particularly* to agriculture'.⁴⁵

Arthur Young was not alone in finding the politics of economic reform at the turn of the century to be a disillusioning experience. The task of rebuilding the agricultural economy from the base upwards was far more difficult than anyone had supposed. It must have been particularly dispiriting to find that the ample

⁴¹ 'On the Commercial Errors of England. By Mons. Du Pont, deputy in the National Assembly for Nemours', *Annals of Agriculture* 16 (1791), 158.

⁴² *Annals of Agriculture* 16 (1791), 158.

⁴³ *Arthur Young's Travels in France*, p. 349.

⁴⁴ *Arthur Young's Travels in France*, p. 349: 'The impossibility of levying the *économistes*, land tax, is found in France to be as great in practice as the principles of it were absurd in theory'.

⁴⁵ *Arthur Young's Travels in France*, p. 329.

writings of *philosophes* and *Aufklärer* were not of much use when it came to policy formulation beyond the confines of the private study or the literary salon (see Figure 3.1). But at least events such as the French Revolution or the Napoleonic incursion into Germany served to clear the clutter of old ideas out of the way. It is hard to imagine, for instance, how Albrecht Daniel Thaer could have received a sympathetic hearing for his vision of a 'rational' nineteenth-century agriculture had it not been for the military threat posed by Napoleon. Thaer's moment of opportunity came in 1804 when he entered Prussian State service following the French invasion of Hannover. In 1806, with the encouragement of the Prussian reformers, he established an agricultural school in Möglin just outside Berlin. This development would mark a turning point in German economic thinking in relation to agriculture, for Thaer drew his inspiration not from *Hausväterliteratur* or even from cameralism, but from Adam Smith and Arthur Young.⁴⁶ Apart from the emphasis on the market economy and free trade in the products of the land, the advocates of 'rational' husbandry were convinced that the time had now come to equip agriculture with a scientific methodology rooted in experimentation (see pp. 164–8). Reinvigorated by the theories of the political economists, German agricultural thought began to pull away from the cameralist curriculum and constitute itself a discipline in its own right.

AGRONOMY

In agreeing to set up the Möglin institute Thaer was conceding, along with an entire generation which had observed from afar the thwarting of the French revolutionaries' agrarian agenda, that it would be much easier to train up an elite of experts than to bring agricultural enlightenment to the common man. He divided the curriculum of his establishment into three main areas of study: 'agronomy', 'agriculture', and 'production'. The word 'agronomy'—meaning the management of the fields had scarcely existed in the eighteenth century. No English usage is recorded before 1814, although the substantive 'agronomist' started to appear quite widely in French circles from the 1760s. Seeking to explain the use of this neologism, a French reviewer drew a parallel between an *agronome* who oversaw an agricultural estate and an *astronome* who pored over the night sky.⁴⁷ Within a couple of decades, however, the word seems to have acquired pedagogic overtones as a description of someone who actively provided instruction in agricultural matters. Then, in 1798, the dictionary of the Académie Française added a further layer of meaning: agronomy was defined as a theory of

⁴⁶ Marion W. Gray, 'From Household Economy to "Rational Agriculture": The Establishment of Liberal Ideals in German Agricultural Thought', in Konrad H. Jarausch and Larry E. Jones (eds), *In Search of Liberal Germany: Studies in the History of German Liberalism from 1789 to the Present* (New York, 1990), pp. 25–54.

⁴⁷ See Elie Fréron's review of P.-A. Allet, *L'Agronome ou dictionnaire portatif du cultivateur* (Paris, 1761), in *L'Année littéraire* (1761).

agriculture informed by the practical sciences, particularly the rapidly developing science of chemistry.⁴⁸

None of this sheds much light on who the agronomists were in the middle decades of the eighteenth century, though, or on how they related to other economic thinkers and practitioners. Some authors have been content to lump them with the physiocrats, although this will not satisfy André Bourde who wrote an extremely thorough book examining every aspect of the literature on agricultural improvement in eighteenth-century France.⁴⁹ Nor will it satisfy Liana Vardi, the most recent author to explore the cultural environment of the physiocrats.⁵⁰ According to Bourde the agronomists were not system-builders but empiricists who mostly avoided social speculation and concentrated their efforts on the search for optimal agricultural techniques, whether in the domain of field systems, crops and cropping cycles, stock-raising, or farm implements and machinery. As such they were not ideologues convinced of the production advantages of large landholdings over small, and they willingly turned their attention to a much wider range of agricultural activities than simply grain growing, not least to animal husbandry. Vardi endorses this demarcation from the physiocrat perspective and reminds us that those labelled 'agronomists' considered themselves to be practitioners of rural economy first and foremost.

In all probability it was the mid-century vogue for translations of agricultural treatises and manuals, usually but not exclusively from English originals, that helped to fashion the French agronomists' distinctive outlook.⁵¹ The naval engineer and savant Louis-Henri Duhamel du Monceau (1700–82) played the key role in this process. Having been sent on a mission of inspection to England by government ministers in order to gather information on port installations, he developed his auxiliary interest in botany and agriculture and introduced his countrymen to the ideas enshrined in Jethro Tull's *Horse-Houghing Husbandry*, first published in 1731. Although Duhamel's *Traité de la culture des terres* which began to appear in 1750 started off as an effort to convey the essence of Tull's book, it soon became much more than this. A shorter two-volume distillation of Duhamel's knowledge discoveries and experiments then followed about a decade or so later bearing the title *Eléments d'agriculture*.⁵² These works encouraged the belief that a new style of agriculture founded on innovatory practices lay just around the corner.

The precise nature of Tull's innovatory practices need not detain us at this stage, or the fact that a description of the widely admired Norfolk system of crop rotation had appeared in the *Encyclopédie* as early as 1754. Suffice it to say that Duhamel's writings enabled the debate about the role of agriculture in learned circles to move beyond the abstractions that partisans of physiocracy and political

⁴⁸ Margairaz, *François de Neufchâteau*, p. 489.

⁴⁹ Bourde, *Agronomie et agronomes*.

⁵⁰ Liana Vardi, *The Physiocrats and the World of the Enlightenment* (Cambridge, 2012).

⁵¹ In this connection see Sophus A. Reinert, *Translating Empire: Emulation and the Origins of Political Economy* (Cambridge, MA, 2011), p. 58 and figure 1.5.

⁵² Translated into English as *The Elements of Agriculture by M. Duhamel du Monceau [...] by Philip Miller FRS*. 2 vols. (London, 1764).

economy habitually dealt in. André Bourde comes close to defining the new breed of agronomists as in essence technicians, or what would be called 'rural engineers' from the middle of the nineteenth century.⁵³ Not surprisingly, they were men who could draw on some knowledge of the natural sciences. They would borrow freely from savants such as Linnaeus (the sources of plant nutrition), Priestley and Bergman (the role of gases and respiration in plant physiology), Daubenton and Huzard (veterinary medicine), chemists (the analysis of soils and manures), and even from the later cameralist writers (tree crop cultivation and forestry). When Albrecht Daniel Thaer stipulated that the curriculum of studies at Möglin should include agronomy he chiefly had the latest developments in soil science in mind. However, when in 1815 the new Dutch monarchy resolved to preserve three chairs of *Landhuishoudkunde* (Land-Household Studies) in the universities of Utrecht, Leiden, and Groningen it was the cameralist tradition imbibed by William I during his exile in Prussia that was uppermost.⁵⁴

The pioneer attempt to analyse in a systematic manner the composition of soils and to tabulate the results according to fertility value (see pp. 168–71) has earned for Thaer the accolade of one of the founding fathers of scientific agronomy.⁵⁵ Yet the transition to a science-based discipline in the first half of the nineteenth century was not automatic, nor was it uneventful. We have already noted how the ideological 'fall-out' of the French Revolution across Europe tended to curtail utopianism in the agrarian sphere. This almost certainly speeded up the acceptance of agronomy as a distinct branch of knowledge, whether among rulers and statesmen or the educated but now somewhat jaundiced public. After all, its strengths lay principally in the non-contentious areas of private research and farm-based experimentation. Full scientific accreditation waited upon the institutionalization of the discipline and the emergence of a class of professional agronomists. Both of these developments lie largely beyond the scope of our study, however. It is nonetheless true that the very first agricultural research or experiment stations came into being in France and Great Britain in the 1830s and 1840s (see pp. 180–3). Until that time the direction in which agronomy would travel remained uncertain. In the eyes of many, perhaps the majority of ordinary, unsung practitioners it remained a field discipline which had relatively little to learn from the laboratory sciences.

With the return to peacetime conditions after more than two decades of near constant warfare everyone was anticipating a reversion to normality. On the cessation of hostilities in 1814–15, however, it soon became apparent that there was little agreement as to what normality in the economic sphere presupposed, let alone how to go about reinstating it. Agricultural Enlightenment in several parts of Europe had

⁵³ Bourde, *Agronomie et agronomes*, i, p. 366.

⁵⁴ See Harro Maat, *Science Cultivating Practice: A History of Agricultural Science in the Netherlands and its Colonies, 1863–1986* (Dordrecht, 2001), pp. 29–31.

⁵⁵ See Robin, Aeschlimann, and Feller, *Histoire et agronomie*, p. 59; Christian L. Feller et al., "The Principles of Rational Agriculture" by Albrecht Thaer (1752–1828): An Approach to the Sustainability of Cropping Systems at the Beginning of the 19th Century', *Journal of Plant Nutrition*, 166:6 (2003), 687–98.

started to metamorphose into full-blown Agricultural Revolution, whereas nearly everywhere else the rural economy was responding to the stimulus of market forces to a degree far greater than had been the case in 1750—aristocratic landowner nostalgia for a return to the *ancien régime* notwithstanding.

In a number of countries agriculture had boomed during the war years under the impact of neo-physiocratic policies designed to attract investment so as to safeguard the food supply. But this capital was now marooned, so to speak, and subject to diminishing returns as agricultural commodity prices plunged. The effect was particularly noticeable in Scotland and in eastern England where tracts of rather marginal land had been enclosed at great expense following the resumption of the conflict with France in 1803. Enclosure, after all, had been billed as an act of purest patriotism. A decade or so later it would become apparent that such capital expenditures might have been better employed in the improvement of existing arable surfaces. Not the least virtue of Britain's Corn Laws in the eyes of landowners was that they provided some protection for these ill-starred investments.

But Corn Laws, wherever they were introduced, also preserved the illusion that Europe's organic economy had not been irretrievably compromised. Once post-war market volatility had subsided, the old balance between agriculture, industry, and commerce would surely be restored. This was not to be, of course. The productive potential of industry and trade within a globalizing economy had begun to register. Labour would become more valuable than land, and when manufacturing industries expanded in zones of productive cereal agriculture as in Normandy and Champagne or in Saxony competition ensued. Employment within the rural economy remained the norm in the early decades of the nineteenth century, however, and in nearly every European country it continued to increase in absolute terms. In many parts of Europe, therefore, the main issue preoccupying political economists was not so much how to maintain prices and profit margins as how to feed both town and country dwellers in this new age of unremitting population growth.

2

The State and Agrarian Reform

The new economic discourses examined in chapter one did not emerge from the æther. They were driven by the first intimations of population growth, by the Enlightenment's culture of 'can do' utilitarianism which had Europeans firmly in its grip by the 1760s, and by the intensification of Great Power rivalries. Contemporaries liked to distinguish between what they termed the 'physical' causes bearing on agriculture and the 'moral' causes. The apparatus of government, along with institutions and ideology fell into the latter category, whereas the constraints of the natural environment in which agriculture was practised, together with the impact of the seasons, made up the physical realm. Arthur Young's Suffolk neighbour John Symonds¹ drew this distinction when contributing to the *Annals of Agriculture* an essay 'Upon the Effects of Government on Agriculture in Italy'. The Comte de Chaptal would also employ it when seeking to differentiate government policy objectives which might very well be political or social in character from the narrowly technical challenges posed by alterations to land use or farm size.²

Of course governments in the eighteenth and the early nineteenth centuries varied hugely in their capacity and also in their readiness to intervene in matters to do with agriculture. The basic presumption was that the State had no business entering the private arena of lord-peasant relations. In Spain where agricultural initiative-taking was episodic and often ineffective this no doubt reflected, among other things, the weakness of the central power in its dealings with noble elites and powerful municipalities. But in Great Britain it passed for an article of faith, or common law, that the relationship between landlord and tenant was sacrosanct. In 1804 the English agricultural writer William Marshall remarked that there existed no legal authority other than a special Act of Parliament which could force a landlord to take steps to improve his property if he chose not to do so.³ The difficulty continental governments increasingly encountered when trying to kick-start reform lay precisely here: in the fact that the lord-peasant relationship could not be granted immunity from interference if the desired policy objectives were to be

¹ *Annals of Agriculture*, 13 (1790), p. 2.

² Jean-Antoine Chaptal, *Chimie appliquée à l'agriculture*. 2 vols. (Paris, 1823), i, p. xxxvi.

³ 'A proprietor may suffer his estate to lie waste, with impunity; provided he thereby injures no man's property', W. Marshall, *On the Landed Property of England, an Elementary and Practical Treatise* (London, 1804), p. 28, cited in R. Bruton, 'The Shropshire Enlightenment: a Regional Study of Intellectual Activity in the Late Eighteenth and Early Nineteenth Centuries' (PhD dissertation, University of Birmingham, 2015), p. 154.

achieved. Many a ruler asked his counsellors the question 'how can agricultural reform be accomplished without disrupting the existing social order?' The answer that came back, generally speaking, was that technology on its own could not provide a solution. Every act of enclosure, every adjustment to cropping practices, and every move to replace sickle with scythe carried a social and a political price tag.

Historians have long taken for granted the role of the State in helping to launch the process of Agricultural Enlightenment. The table of emancipation decrees presented in Jerome Blum's magisterial volume *The End of the Old Order in Europe* speaks for itself. It starts with the statute promulgated by Charles Emmanuel III in 1772 laying down a procedure for the transformation of Savoyard peasants into free-holders and finishes with the legislation of Alexandru Ioan Cuza of the Danubian Principalities which in 1864 introduced the notion of individualized property holdings to the future state of Romania.⁴ It should be emphasized, however, that these were all measures designed primarily to extinguish seigniorial lordship and bring an end to servility, if not serfdom, in Europe. They do not bear direct witness to the chronology, the geography, or indeed the mechanics of agricultural reform. Nevertheless, historians have used them as a rough proxy measure of the rate of modernization of agrarian structures across Europe. The obvious drawback of this approach is that it tends to create a 'before' and 'after emancipation' divide which denies the possibility of economic growth and a transition to monetized contractual relationships *within* the servile economy. As we shall see, manorialism was a highly flexible institution which posed no insuperable barrier to innovative practices and enhanced agricultural productivity.

A less obvious, but no less important objection to the focus on edicts of emancipation is that it attributes too much importance to Statist initiatives in the realm of agriculture. Whilst one group of rural historians draws inspiration from institutional economics and maintains that the character of a country's institutional structures has an important bearing on economic performance, another is more inclined to emphasize the primary role of markets—their size and degree of integration—in an approach that derives ultimately from development economics. Of course markets required an appropriate institutional framework if they were to function effectively. Nevertheless, the role of markets and the capacity of peasant farmers to respond to the opportunities they enshrined while still subject to the jurisdiction of the lord of the manor is something we will need to keep in mind. It is, after all, quite hard to measure the 'efficiency' of an institution, or to establish a clear causal connection between an agrarian reform initiative and a net increase in food output enabling the spectre of a Malthusian population crisis to be banished, or at least held at bay.

But can we be confident that the 'pull' of markets *alone* drove forward agricultural change in the period of Agricultural Enlightenment? This argument finds little favour with historians of Scandinavia where institutional land reform was both precocious and sustained, and palpably a cause of economic growth. Market

⁴ Jerome Blum, *The End of the Old Order in Rural Europe* (Princeton, NJ, 1978), p. 356.

'pull' implies significant urbanization on the continent of Europe, infrastructure improvements and the development of long-distance grain transportation—all developments that chiefly made an impact towards the end of our period of study. In the German-speaking territories, as we shall see, the implementation of agricultural reform from above occurred quite late and in instalments. It is perhaps no surprise, therefore, that a more recent generation of German economic historians should prefer to lay the stress on the flexibility of manorialism and to highlight the role played by the incipient industrialization of the 1840s in reconfiguring the agrarian economy.

It is true, of course, that governments intervened in the agricultural economy for different and sometimes overlapping reasons. In central Europe and also in Spain persistent anxieties over population *loss* stemming from rural emigration or low levels of demographic fertility were often paramount in the decision to intervene—long before, that is to say, the construction of an explicit agenda of agrarian reform. However, once rulers had learned how to analyse and assess the sources of wealth within their kingdoms, humanitarian considerations also entered the picture. Philosophers across Europe hailed the decision of the king of Sardinia (Charles Emmanuel III) to use his despotic powers to curtail the rights of noble and ecclesiastical landowners in Savoy, and there are grounds for supposing that humanitarian, or at least rationalistic, impulses came to the fore in Bohemia as well. During the later years of Maria Theresa's long reign recognition of the servile peasantry as a source of taxable wealth was joined by a growing awareness that serfs had a claim on the State's attention as individuals in possession of rights like anyone else.⁵ By the 1760s the notion of 'public good' was starting to make headway in chancelleries all over Europe.

Not quite everywhere, however, for Britain remained out of step. Only in the 1790s did British statesmen seriously contemplate intervention in the agricultural sphere, and they did so chiefly for circumstantial rather than structural reasons.⁶ The war with revolutionary France was going badly, continental markets for manufactured goods were being lost and in London anxiety over the long-term security of food supplies was mounting. In marked contrast to the continental monarchies, a quasi-Smithian notion of the public good prevailed. Foreign visitors rarely failed to notice the difference and we can take the measure of it from comments consigned to their travel journals and letter correspondence. On touring Britain's rural counties and industrial districts François de La Rochefoucauld observed, 'throughout this country, no rules, nothing forbidden, nor need of encouragement of any kind: the greatest of all encouragements, for any class of people whatever, is their own personal interest and the personal interest of a large collection of individuals constitutes the interests of the State'.⁷

⁵ William E. Wright, *Serf, Seigneur, and Sovereign: Agrarian Reform in Eighteenth-Century Bohemia* (Minneapolis, 1966), pp. 40–1.

⁶ On the momentary politicization of the 'improvement' agenda and its repercussions in Britain's colonies, see Richard Drayton, *Nature's Government: Science, Imperial Britain, and the Improvement of the World* (New Haven, CT, 2000), p. 88 and *passim*.

⁷ Scarfe, *A Frenchman's Year in Suffolk*, p. 148.

Perhaps he was simply repeating the opinions of his travelling companion and tutor Maximilien de Lazowski, but such remarks occur too frequently to be ignored. England and the English, in the judgement of well-informed outsiders, had advantages that other countries simply did not have. There existed no accretions of civil law acting against the interests of agriculture; the tax system did not bear down harshly on the rural economy; and the culinary habits of the nation (conspicuous consumption of meat and dairy products) gave an appreciable boost to animal husbandry. The French industrial agent and investigator Bonaventure-Joseph Le Turc also noted the relaxed attitude of the British government in matters to do with the economy. Whereas the French government is quick to offer incentives to industry, he wrote in 1787, 'in England, with a few rare exceptions, the State takes no interest in the matter; it considers, rightly, that a patent granted for a fixed term is of greater advantage, not only to the author but also to the public, than a meagre pecuniary recompense'.⁸

THE ANCIEN RÉGIME

Pressures associated with the costs of warfare were inescapable in the eighteenth century and it is no accident that they came to a head in the 1750s, 1760s, and 1770s. Between 1756 and 1763 Great Britain, Prussia, Portugal, France, Spain, Austria, and Russia, together with their lesser allies, fought the Seven Years' War. It was the first European conflict to be waged on a global scale as well as being the largest disputed on German soil since the seventeenth century. The damage to State finances was considerable and even countries such as Denmark-Norway, which had contrived to remain neutral, subsequently embarked on fiscal recovery programmes targeting trade, industry, and agriculture.⁹ It was as though a decade of economic debate had prepared the ground for a reflex of collective action by States to tap into the wealth-generating potential of the rural economy. Arthur Young was not alone in remarking on the suddenness with which the question of agriculture had moved up the political agenda: 'after the peace of Aix-la-Chapelle [1763], almost all the European nations, by a sort of tacit consent applied themselves to the study of agriculture and continued to do so, more or less, even amidst the universal confusion that soon succeeded'.¹⁰

As the costs of Great Power rivalry escalated, so the fiscal-military State was forged. How the relentless quest for revenue could become a tool of modernization in the hands of government was first outlined by Joseph Schumpeter.¹¹ He envisaged

⁸ A. D. Oise 6jp 14 Memorandum of B.-J. Le Turc, Paris, 10 October 1787; also J. R. Harris, *Industrial Espionage and Technology Transfer: Britain and France in the Eighteenth Century* (Aldershot, 1998), pp. 448–52.

⁹ Denmark was threatened with war by Russia in 1762 in a dispute over Schleswig.

¹⁰ *Letters concerning... the French Nation* (Dublin, 1769) cited in Bourde, *Agronomie et agronomes*, i, p. 439 n. 4.

¹¹ Joseph Schumpeter, 'Die Krise des Steuerstaates [1918]' translated as 'The Crisis of the Tax State' in Alan T. Peacock et al., *International Economic Papers: Translations Prepared for the International Economic Association*, no. 4 (London and New York, 1954), pp. 5–38.

a transition from a medieval regalian State in which the Crown financed a rather limited range of government activities from its own private domain income to a tax-based State which alone could generate resources on a scale to support the hegemonic ambitions of early modern rulers. However, taxation conceived as an ongoing and indeterminate commitment was bitterly resented and had been the cause of many a revolt in the seventeenth century. With the notable exception of England, an uneasy *modus vivendi* resulted in most continental monarchies and principalities according to which some owners or occupiers of land and buildings were subjected to direct taxation by the State and some were not.

This was the compromise which rulers of States big and small now sought to re-visit. The peace treaty of 1763 provided both the opportunity to take stock of the reconfigured international landscape and the cue for action. France (Louis XV), the Habsburg Empire (Maria Theresa and Joseph II), Russia (Catherine II) and even Prussia (Frederick II) which had successfully resisted three much larger Powers during the course of the war all launched agricultural reform initiatives of some description. In Spain the momentum came from Carlos III who had acceded to the throne in 1759, although it is true that important fiscal reforms had started under his predecessor Ferdinand VI. Lesser rulers followed suit in the knowledge that the very survival of their principalities would be at stake in the event of another large-scale continental conflict. Thus Saxony under elector Friedrich Christian embarked on an overhaul or *rétablissement* of its finances even before the war had come to an end. Hesse-Cassel which had been reduced to a virtual wasteland by warfare did likewise. Landgrave Friedrich II put his cameralist-trained bureaucracy to work on a recovery programme—all too aware that subsidy payments from Great Britain would cease in 1770. Whilst priority was accorded to trade and industry, the fact that the ruler was the *Grundherr* of two-thirds of Hessian farmland created an unusual if not unique opportunity to trial both the New Husbandry and the commutation of labour services. In fact Friedrich's officials urged him to copy the example of Denmark and convert his demesne into hereditary leaseholds (*Erbleihe*) on the principle that free wage labour would increase productivity and contribute both to peasant well-being and to the revenues of State. This seemed like a step too far, though, until the harvest disasters of 1770–71 intervened.¹²

It was easiest to trial agricultural reform on Crown-owned estates, or in regions where by accident of history (dynastic or military) rulers had the upper hand vis à vis local nobilities. We find this pattern reproduced in France where Louis XVI tried to set an example in Franche-Comté by abolishing *mainmorte* and also in Denmark where Christian VII was the dominant landowner in Zealand. In the Habsburg lands Maria Theresa and Joseph initially experimented with a cautious intervention to curtail labour service (the *robot*) on Crown and ex-Jesuit estates in Bohemia and Moravia. In every case the aim was to detach peasants from manorial or seigniorial control and stimulate the growth of a class of hereditary tenants who might, in the fullness of time, become independent free-holders. By a process of

¹² Charles W. Ingrao, *The Hessian Mercenary State: Ideas, Institutions and Reform under Frederick II, 1760–1785* (Cambridge, 1987), pp. 68–73, 91, 104.

emulation, self-interest, or else fear that vassals might flee or migrate elsewhere, private landlords would follow suit. At least this was the theory.

The necessary preliminary to structural reform of the rural economy was an exact knowledge of resources. This is what the new intellectual discipline of *Statistik* set out to provide. If land was now recognized as the primary source of wealth, the very first step must be to measure it and find out who owned it. Cadastration (the compulsory surveying of agricultural and non-agricultural land) became the reformers' mantra, therefore. Cameralist-minded rulers could see a virtue in the registration and classification of landholdings for its own sake, of course, but the pressures which prompted a number of governments to launch hugely expensive and contentious programmes of this sort during and after the Seven Years' War were fiscal for the most part. The connection is most obvious in the case of Bourbon France where in 1760 chief minister Henri Bertin instructed the intendants of the provinces to start gathering up practical knowledge with a view to making recommendations for the 'extension and perfection of agriculture'.¹³ Three years later, having been emboldened by victory over the Jesuits, the government announced plans to carry out a general land survey. Bertin quit his office of Controller General, however, and the physiocrats soon found fault with the proposal. Nothing came of the initiative in consequence: only on the island of Corsica which the French acquired in 1769 would cadastral mapping go ahead. Yet fresh calls to survey all landholdings without exception would be issued at intervals during the closing years of the *ancien régime* and throughout the revolutionary decade. A comprehensive cadastral survey was finally put in hand in 1808 by the vastly more effective Napoleonic regime.

The shift in focus from industry and commerce to agriculture in the 1750s, 1760s, and 1770s was also much in evidence in the German territories. In Vienna, the Habsburgs considered Austrian Lombardy to be an obvious site for fiscal experimentation since the plains of the Po River were highly fertile and given over to capitalist farming for the most part. A survey of landownership (the *censimento*) was carried out in order to provide a foundation for the universal and proportional land tax promulgated in 1760. Progress in the heartlands of the Habsburg Empire came more slowly, though. Maria Theresa conceived plans for a survey of landholdings in order to increase the scope of State taxation following the loss of Silesia, but it seems that little was actually achieved. It fell to Joseph II to order the systematic cadastral mapping of all arable land in 1785. Scheduled for completion within six months the work was still in progress two years later, which in turn delayed the launch of his new land tax until 1789. Lesser states generally had more success in pushing through cadastral surveys: Victor Amadeus, the Duke of Savoy, in 1728–30; Charles William Ferdinand, the Duke of Brunswick-Wolfenbüttel, between 1746 and 1784; and William Henry, Prince of Nassau-Saarbrücken, in the immediate aftermath of the Seven Years' War.

¹³ Bertrand Gille, *Les Sources statistiques de l'histoire de France: des enquêtes du XVIII^e siècle à 1870* (Geneva and Paris, 1964), pp. 44–5.

Joseph II insisted that the purpose of cadastration was not to intensify overall fiscal extraction but to ensure that the burden was distributed more evenly by means of an impost on land holdings levied across the board.¹⁴ This was disingenuous for investigation nearly always brought to light surfaces owned by no one in particular and therefore not contributing any tax to the exchequer. In cases where States opted to create their own professional corps of surveyors as in Sweden and Denmark (after 1769), such discoveries were even more likely to occur. In any case the purpose was not solely to assess accurately the value of crop-bearing land, but to tap into the wealth-generating potential of agriculture now that the continental war had come to an end, trade routes were reopening and commodity prices rising. In the best conceived survey operations this agronomic imperative is quite transparent. The aim was either to administer a fiscal shock to hitherto tax-exempt landowners and corporate bodies in order to spur them down the path of modernization, or to create incentives which would encourage dutiful land-tax payers to lift their production thresholds. Thus the Lombard *censimento* determined the net yield of every parcel of land whilst at the same time offering owners the assurance that the tax load would not increase even if yields were subsequently to rise. Owners and tenants of farms would pay lower taxes, proportionately speaking, as production expanded, but were crop yields to decline then the fiscal burden on the land would increase in weight. As a result of the *censimento* 'inertia is punished and diligence is rewarded', as one Lombard official put it.¹⁵

Assessment of the yield of an individual parcel of agricultural land, whether enclosed field or open strip, was no easy matter of course. Nor for that matter was its measurement. Accurate measurement and its concomitant, maps and plans drawn to scale employing a geometric rather than panoramic mode of representation was one of the achievements of Agricultural Enlightenment. Thanks to technological improvements in the measurement of angles, the margin of land-surveying error dropped from around 15 to 20 degrees in the seventeenth century to 1 degree by the end of the eighteenth.¹⁶ The Italian surveyors set the standard with the geometrical parcel survey of the Duchy of Milan completed between 1718 and 1757. Their skills would be in heavy demand as a result. Elsewhere, however, surveying remained a rather rough-and-ready activity for want of practitioners with a sure grasp of the technology of triangulation. Surveyors, together with military engineers, were among the first occupational groups to draw practical benefit from the mathematization of nature by Europe's savants. In France there is not much evidence that triangulation was used at the start of the eighteenth century, yet seventy years later the whole island of Corsica would be successfully surveyed on the basis of a grid of primary and secondary triangles.

The precise reckoning of land surfaces for taxation purposes was only one intervention in the rural economy among many that war and post-war dislocation brought to a head. Governments also intervened in an effort to ensure that more

¹⁴ Link, *The Emancipation of the Austrian Peasant*, pp. 134, 140.

¹⁵ Alexander Grab, 'Enlightened Absolutism and Commonlands Enclosure: the Case of Austrian Lombardy', *Agricultural History*, 63:1 (1989), 55.

¹⁶ Jean Peltre, *Recherches métrologiques sur les finages lorrains* (Lille and Paris, 1977), pp. 135–6.

land was brought under the plough, whether by the clearing of waste ground or the dividing up of collectively owned pastures, and to remove legal and institutional impediments to the ownership of property and the enclosure of private land. Throughout much of Europe individual landholdings took the form of long strips distributed in open-fields whose cultivation was rotated at regular intervals. There were even some timid attempts to promote the consolidation of these strips into larger blocks of farmland (see chapter eight). Governments generally proceeded with caution, however. They were aware that agricultural interventionism involved a major policy shift and that any disturbance of agrarian structures might have unlooked for consequences. Climatic events such as the famine of 1768–69 in Galicia, the two wet summers of 1770 and 1771, the spring drought of 1785, the savage winter of 1788–89, or the cold and damp of 1816–17 could act both as a deterrent and as an incitement to reform. Moreover, there were parts of Europe (Andalusia; the Ukraine) where it was not land but the labour to cultivate it which was the central issue. Catherine II of Russia inaugurated her long reign with Imperial Manifestoes offering inducements to German farmers to move to the virgin soils of the Volga region and in 1766 Carlos III of Spain endorsed a similar initiative to repopulate the Sierra Morena (see p. 114).

The gravity of the policy shift involved in trying actively to manage the rural economy should not be underestimated. In the 1750s and early 1760s at a time when thoroughgoing agricultural reform had yet to emerge clearly at the top of the agenda, the Austrian authorities pursued a conservative approach towards lands held in common by village communities. The fear was that their privatization might lead to depopulation rather than a boost to production, or an increase in revenue for the Imperial treasury; in 1763 Vienna actually intervened to force the restitution of common lands which had been leased or sold off in Lombardy. But then, in 1768, Maria Theresa reversed the policy and promulgated a general edict requiring common pastures to be divided up throughout the Empire. Further edicts followed prescribing physical enclosure with hedges, although their very repetition hints at the resistance of local bureaucrats and the impracticality of the policy in upland pastoral zones. In Lombardy partition resumed in 1779—in the name now of agricultural efficiency. The *cessimento* was in operation and after several years of dearth, grain prices were steadily rising. Besides, the luminaries of the Italian Enlightenment backed the policy as did chancellor Kaunitz in Vienna. Grain was second only to raw silk as Lombardy's biggest export crop and after years of procrastination deregulation of the trade in cereals was waiting in the wings.

By comparison with the Habsburgs, the French Bourbons moved firmly and relatively swiftly to exploit the post-war conjuncture. Physiocracy had made a number of converts in the highest councils of State and in the space of two decades (1761–81) French government ministers targeted agriculture with more facilitating laws and general measures of encouragement than had been issued over the previous eighty years.¹⁷ In swift succession there were interventions to promote

¹⁷ For a list of the principal edicts, see Béaur, *Histoire agraire de la France au XVIII^e siècle*, p. 79.

land clearance (1761 and 1766) and a series of province-by-province edicts to enable, but not enforce, the division of common pastures and the enclosure of private landholdings (1767–81). The Duke de Liancourt caught the mood early on and in 1760 submitted plans to divide up the commons of his marquisate, only to be told by the minister-in-charge that he should make all possible speed ‘so that we can get the measures signed off along with a score of others which are ready’.¹⁸ There was even a cautious acknowledgement of the need to curtail common rights—without which any signal to landowners that the government wished them to enclose their properties was unlikely to receive a positive response. In Lorraine, for instance, enclosure was authorized in 1767 and partition of the commons in 1771, with the rider that the inter-commoning of flocks should be discontinued. This latter caveat did not go down well with commercial graziers who managed to block it. The same thing happened in Burgundy between 1770 and 1774 where the Parlement of Dijon refused to countenance any curtailment of pasturing rights despite welcoming the removal of the ban on enclosure.

As was the case in nearly all of the *ancien régime* monarchies, France’s ministers and bureaucrats understood perfectly well that agricultural reform could only proceed by consent. Elites had to be offered incentives to participate, and the subsistence needs of the rural masses could not be ignored no matter how pressing the case for reform appeared to be on intellectual grounds. Whilst the enclosure of landholdings and the dividing up of common land implied an end to common rights such as stubble grazing and gleaning, no government was prepared to spell this out explicitly in legislation. It was much easier to offer inducements in exchange for the forfeiting or the blurring of ‘collective rights’. The expense of land clearance could be rewarded with exemption from State taxes and even the tithe for a number of years, whilst the burden of enclosure and consolidation could be mitigated somewhat if transaction costs arising from the sale or exchange of land parcels were suspended. The Burgundian enclosure edict of 1770 enshrined dispensations of this sort. Only in the area of grain trade deregulation did French ministers take the risk of behaving in a high-handed and authoritarian manner: in 1763–64 centuries of controls on the movement and sale of cereals were scrapped in an over-confident belief that transactions between producers and consumers could be left to market forces. This was a most daring agricultural reform and it lasted only for as long as grain harvests remained in surplus; that is to say until bread prices doubled and urban violence threatened. By 1770 the export of grain from the kingdom had been suspended and the panoply of controls restored.

The Spanish Bourbons experimented with internal grain trade de-regulation in 1765 as well. Agricultural reform with a view to improving the food supply to the cities and, in the longer term, contributing to the kingdom’s fiscal recovery had been bruited since the accession of Ferdinand VI in 1746. In the 1750s an important preliminary step in this direction had been taken with the completion of the

¹⁸ A. D. Oise 6Jp 13 Dessuile to Barraud, régisseur du Marquisat de Liancourt, St Rimant, 23 July 1760.

Marqués de la Ensenada's *catastro*, or census of property-holdings and wealth.¹⁹ In 1762 the reform impulse crystallized when Pedro Rodríguez, the future Conde de Campomanes, emerged to a position of influence in government. Campomanes was an agrarian specialist with a broad, physiocrat-inspired vision of the future. It embraced land reform (to create a class of small independent farmers), cattle breeding and the encouragement of 'popular' or cottage industry in addition to the liberalization of the corn trade.²⁰ He was seconded in his efforts by Pablo de Olivade, intendant of Seville, who would play a major role in the project to bring in settlers to colonize the empty spaces of Andalusia (see p. 114). Their attempt, with royal support, to introduce 'rural revolution from above'²¹ lasted for around seven years and it promised far more than it actually delivered. The removal of price controls on grain proved disastrous and resulted in urban riots which forced Carlos III to flee Madrid. Attempts to open up municipal land and common pastures for distribution to agricultural workers on reasonable rents were impeded by local oligarchs; only the colonization project which collided with relatively few vested interests enjoyed a measure of success. Pablo de Olivade would eventually be investigated and detained at the behest of the Inquisition, and although Campomanes received some support subsequently from the Conde de Floridablanca, he only managed to chip away at the privileges enjoyed by the Mesta flock owners; privileges which effectively placed a permanent block on the enclosure and cultivation of private land. In 1793 farmers did receive some encouragement to plough up their pastures so as to increase cereal production, but the permission granted by royal decree was confined to the province of Extramadura.²²

Prussia's main response to the challenges manifested during the Seven Years' War was to put virtually all mining and heavy industry in the hands of the State. Henceforth an elite of 'savant officials'²³ equipped with a blend of natural knowledge and technical expertise would drive recovery and territorial expansion in the age of the Polish partitions. Nevertheless, Frederick II was not immune to the economic messages enshrined in Agricultural Enlightenment. Sir John Sinclair, president of the London Board of Agriculture, would later claim that the warrior monarch devoted £300,000 per annum to agricultural improvement. Much of this expenditure involved the buying-in of agricultural 'know-how' from Britain after Johann Christoph Wöllner alerted the Prussian reading public to the agricultural developments taking place in England and Scotland; developments which he juxtaposed damningly with the largely manorial economy of the Electorate of

¹⁹ See Carlos Santiago-Caballero, 'Trapped by Nature: Provincial Grain Yields in Spain in the mid-18th Century', *Revista de Historia Económica/Journal of Iberian and Latin American Economic History*, (January 2015), 5–6. DOI: 10.1017/S0212610913000165.

²⁰ Niccolo Guasti, 'Campomanes' Civil Economy and the Emergence of the Public Sphere in Spanish Ilustración', in Jesús Astigarraga and Javier Usoz (eds), *L'Economie politique et la sphère publique dans le débat des Lumières* (Collection de la Casa Velázquez no 135, 2013), p. 240.

²¹ Herr, *Rural Change and Royal Finances in Spain*, p. 41.

²² James Simpson, *Spanish Agriculture: The Long Siesta, 1765–1965* (Cambridge, 1995), p. 66.

²³ Ursula Klein, 'Savant Officials in the Prussian Mining Administration', *Annals of Science*, 69:3 (2012), 349–74.

Brandenburg. In 1766 Wöllner published a critique of the commons of Brandenburg which, in its French-language edition, he dedicated to Frederick II. From that point on the king became an implacable opponent of unproductive land and a partisan of enclosure on Crown estates.

As we have noted, the difficulty lay in persuading the nobility to follow suit. Initially, Frederick employed the tactic of dispatching promising individuals (the sons of Crown tenants) to be trained in the new forms of husbandry on farms in the English counties. On their return they would not only revitalize royal estates but would, by virtue of the process of 'emulation' (see pp. 85–91) which lay at the heart of Agricultural Enlightenment, encourage noble landowners to improve their own demesnes and the lot of their tenants. This was the theory at least. In 1767 the king changed tack, however, concluding that it would be more cost-effective to hire skilled farmers in England and bring them over to Prussia. There was certainly an element of posturing in Frederick's agrarian policies which, after all, were not his main priority. Effective interventionism, as we shall see, waited upon his successors and the critical situation in which the country found itself following the Napoleonic incursion of 1805–06. In the meantime symbolic acts of red clover and turnip planting took place in Brandenburg, but with little real understanding of the soil conditions which each of these forage crops required. The Feudal Chamber was in charge of the operation and selected the trial sites, ruling that 'the experiment in English agriculture must be made on the route to Frankfurt-on-Oder, at Rüdersdorf, Fürstenwalde and Pilgram on the estate of Biegen, because we [i.e. the king and his councillors] frequently pass through this district'.²⁴

Some of the lesser German states copied Frederick II and tinkered with agricultural reform as well. The attempt by Margrave Carl-Friedrich of Baden-Durlach to establish the physiocratic land tax has already been mentioned; it was anticipated in a series of initiatives introducing new crops and rotations which were intended to set an example and point the way ahead.²⁵ The war on the commons was waged by the government of the Palatinate Electorate in the 1760s too, but elsewhere the critical interventions in the rural economy occurred later—either in the aftermath of the French Revolution, or in response to challenges to the political order arising in the first half of the nineteenth century. The only other region where actions by governments signally aided and abetted the cause of agricultural reform in the late *ancien régime* was north-western Europe.

Schleswig-Holstein was controlled by the Danish monarchy in this period and had long been recognized as a zone of innovative and productive farming. Thomas Malthus and his companions passed through the provinces in 1799 as part of a tour of Scandinavia. 'In the mode of cultivation, in the hedges & ditches, & in the kind of trees in the hedgerows', he remarked, the countryside 'resembled exactly

²⁴ Hans H. Müller, 'Christopher Brown—an English Farmer in Brandenburg-Prussia in the Eighteenth Century', *The Agricultural History Review*, 17:2 (1969), 123.

²⁵ Helen P. Liebel, 'Enlightened Bureaucracy versus Enlightened Despotism in Baden, 1750–1792', *Transactions of the American Philosophical Society*, 55:5 (1965), 40–54.

many parts of England'.²⁶ The agricultural system which he had encountered was known as *Koppelwirtschaft* and it presupposed the splitting up and enclosure of open-fields and the substitution of complex rotations involving perhaps ten or fourteen hedged fields known as *Koppeln*. Yet as Malthus went on to note the peasant farmers remained legally servile and subject to onerous labour services—evidence therefore of a functioning manorial economy and one, moreover, which was capable of considerable flexibility (see pp. 99, 148). By all accounts the system evolved from the bottom up in the seventeenth century as a result of initiative-taking both by innovating manorial landowners and 'free' peasant cultivators.²⁷ The Danish Crown viewed the development with some suspicion, fearing a loss of tax revenue. But when in the second half of the eighteenth century the combination of demesne-led grain and dairy farming proved its economic worth, the monarchy hastened to intervene and to regulate. Edicts were prepared to facilitate land consolidation in the 'free' districts of the Duchy of Schleswig (1766) and subsequently also in Holstein (1767 and 1770) which was a principality of the Holy Roman Empire.

The dates of these measures speak to the pan-European context of agricultural renewal. They also provide a clue to understanding the extraordinary spate of reforms which ministers, bureaucrats and State surveyors visited on the Danish countryside between the 1760s and the 1800s. These reforms will be explored in more detail in chapter six, but it is helpful to summarize them here for Denmark experienced a greater rural transformation than anywhere else in Europe apart from revolutionary France during the final quarter of the eighteenth century. After several years of experimentation on landlord estates in Zealand and Schleswig, King Frederick V agreed to the establishment of an Agrarian Commission in 1757—the forerunner of a permanent Board of Agriculture. The aims of the reformers were all too familiar: the creation of a stable and productive freehold peasantry which was no longer institutionally tied to the manor; the eradication of labour service; the consolidation and enclosure of farm land; the destruction of the village community and communal notions of property right; and the introduction of the new English-style husbandry.

Although none of this happened in a seamless manner and issues such as the commutation of labour service took many years to resolve satisfactorily, the fact remains that the reforms of the authoritarian Danish monarchy *were* implemented on the ground. They were facilitated, moreover, by the establishment in 1786 of a State credit bank which advanced loans for agricultural improvement, including the redemption of manorial obligations—the first institution to do this in Europe. Even the least institutionally inclined historians can agree, therefore, that by 1807 semi-serfdom had been legislated out of existence. Around 60 per cent of peasant

²⁶ Patricia James (ed.), *The Travel Diaries of Robert Malthus* (Cambridge, 1966), p. 45. The landscape of Schleswig-Holstein contained around 80,000 kms of tree-dotted hedges until the 1950s, see the report in the *Sturmarnen Tageblatt*, 12 February 2014 headed 'Der Mann der Knicks', <http://www.shz.de> (accessed 20 March 2015).

²⁷ Wolfgang Prange, *Die Anfänge der grossen Agrarreformen in Schleswig-Holstein bis 1771* (Neumünster, 1971); Carsten Porskrog Rasmussen, 'Innovative Feudalism: The Development of Dairy Farming and *Koppelwirtschaft* on Manors in Schleswig-Holstein in the Seventeenth and Eighteenth Centuries', *The Agricultural History Review*, 58:2 (2010), 172–90.

farms had been converted into freeholds and the consolidation and enclosure of fields had taken place in the majority of localities: 'after having existed for several hundred years, the communal cultivation of fields and the sharing of village amenities faded away within three or four decades, and so did the widespread village autonomy that had existed until then'.²⁸ Why these things had happened offers more room for scholarly disagreement. Were the bureaucrats acting on behalf of the Crown Prince (the future Frederick VI) committed to Agricultural Enlightenment, or to the strengthening of the sinews of Danish absolutism? The two propositions are not mutually exclusive. In the preamble to the tenure legislation of 1787 the government asserted, according to Fridlev Skrubbeltrang, that 'a flourishing agriculture must be considered the most natural and most lasting source of the prosperity of the State'.²⁹

Across the Sound in the Swedish province of Scania there is also clear evidence that agricultural reform was taking hold. Unlike the other European States Sweden had abandoned all pretention to fiscally reinforced military power after losing her dominant position in the Baltic during the Great Northern War (1700–21). It has been suggested that Sweden subsequently retreated from the eighteenth-century Enlightenment as well, although this is scarcely a sustainable proposition if the key cultural denominator of Enlightenment is taken to be the generation and circulation of useful knowledge for the purpose of material betterment.³⁰ Swedish and Finnish intellectuals pioneered instead the application of scientific knowledge to mining, manufacturing, and farming in a conscious attempt to compensate for the losses on the international stage. In the agricultural sphere this 'utilist'³¹ philosophy justified a form of interventionism not unlike that practised in Denmark where the principal active ingredients were improving landowners, enlightened bureaucrats bent on remodelling the rural economy, and knowledge imports from England and Scotland.

As the principal surplus-producing province, Scania became the test bed for Sweden's version of Agricultural Enlightenment. Although the main thrust of government and landlord interventionism occurred somewhat later than in Denmark, much of the grain land had been enclosed there by 1815. The *storskifte* or reallocation reforms to reverse the fragmentation and dispersal of holdings began in earnest in the 1750s and were influenced by England's accelerating Parliamentary enclosure movement. Indeed, the ordinance of 1757 referred explicitly to English practices which had become better known following the publication in 1753 and wide translation of Pehr Kalm's *Account of his Visit to England on his Way to America*

²⁸ Thorkild Kjaergaard, *The Danish Revolution, 1500–1800: An Ecological Interpretation* (Cambridge, 1994), p. 221.

²⁹ Fridlev Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark* (Rome, 1953), p. 41.

³⁰ The view of Tore Frängsmyr, see Vesa K. Oittinen, 'Between Radicalism and Utilitarianism: on the Profile of the Finnish Enlightenment', in Tatiana Artemyeva, Vesa Kalevi Oittinen, and Mikhail Mikheshin (eds), *The Philosophical Age. Almanac. Issue 36: The Northern Lights: Facets of the Enlightenment Culture* (St Petersburg and Helsinki, 2010), pp. 10–13.

³¹ See Hjalmar Fors, *Mutual Favours: The Social and Scientific Practice of Eighteenth-Century Swedish Chemistry* (Uppsala, 2003), pp. 22–6.

in 1748.³² However, the *storskifte* did not directly target three-field agriculture, or the village community as an institution. Thoroughgoing reorganization involving enclosure and significant alterations to the human habitat waited upon the *enskifte* land reform which was introduced to Scania in 1803 and generalized by decree in 1807. Yet in the meantime Baron Rutger Macklean of Svaneholm in Scania had shown the way ahead. Starting in 1783 he completely re-structured his extensive manor replacing fifty-one farms comprising between 60 and 100 parcels of land each with seventy-three rectangular holdings of 40 acres. Fodder crops could now be introduced and the fallow abolished, assuming always that tenants could be found who were willing to take on the risks of independent farming. The break-up of the village proceeded quite swiftly on the south-western plains as a result, and it was promoted in other areas by the *laga skifte* reform of 1827.³³

Although the English practice of enclosure tended to be viewed as a desirable model to follow on the Continent, governments were rarely able, or even willing, to adopt it lock, stock, and barrel. It suited King Gustav IV Adolphus to push through the *enskifte* decree if for no other reason than the fact that it reduced the institutional capacity of country dwellers to resist autocratic monarchy, but French legislators in the aftermath of the Revolution of 1789 felt very uneasy about copying the English, or indeed the Swedish example. They sought to will the end without willing the means. In their view England's success had been purchased at the cost of landlord coercion of the tenantry and the brutal dispossession of the rural poor without any form of intercession by the State. As N.-L. François de Neufchâteau, the Minister of the Interior, would put it in 1797, 'let us not do good by force'.³⁴

It is true that British governments repeatedly declined to intervene and enact a general enclosure law which took proper account of the 'public' interest. Arthur Young campaigned for a measure which would embrace waste and unproductive land as well as granting allotments to the poor in the 1790s, but it was not until 1836 that a truly comprehensive bill passed through Parliament. Before 1760, broadly speaking, enclosure and the concomitant extinction of common rights happened informally and by negotiation following piecemeal acquisition by a landlord. But after that date a more formal, rapid, and potentially contentious route involving a private bill laid before Parliament was the more usual one. This was the system described candidly by Maximilien de Lazowski in his 1787 memorandum on English agriculture in the following terms: 'at the request of landowners Parliament appoints commissioners who, without appeal, assign to each proprietor an area for the consolidation of his possessions'.³⁵

³² *Kalm's Account of his Visit to England on his Way to America in 1748*. Translated by Joseph Lucas (London, 1892).

³³ Staffan Helmfrid, 'The *Storskifte*, *Enskifte* and *Laga Skifte* in Sweden—General Features', *Geografiska Annaler*, 43 (1961), 114–29.

³⁴ *Arrêté de l'administration centrale du département des Vosges, sur un moyen préliminaire d'encourager l'agriculture dans ce département, par la réunion des propriétés morcelées, et par quelques autres mesures: séance du 15 floréal, an V de la République française, une et indivisible* (Epinal, 1797), p. 63.

³⁵ A.D. Oise 6Jp 14 'Etat de l'agriculture en Angleterre [...]', folio 45.

THE REVOLUTIONARY ERA

In the 1780s weather conditions over western Europe entered a phase of instability. The wet and late spring of 1782 brought a run of good cereal and grape harvests to an end and the following year a desperately cold growing season intervened which climatologists have linked to volcanic dust in the upper atmosphere. In Scotland it produced near famine conditions. The Laki volcanic eruption in Iceland may also explain the pervasive severity of the winter of 1783–84. Benjamin Franklin who was living just outside Paris at the time certainly drew this conclusion.³⁶ For our purposes, however, it was the exceptional drought caused by high-pressure weather systems repeatedly blocking westerly airflows during the late winter and spring of 1785 which forced the hand of governments. In Brittany scarcely any rain fell from early February until the end of July and a chorus of reports by travellers warned of troubles ahead for the rural economy. Passing through the Artois in May, John Adams noted that ‘the Country is a heap of Ashes. Grass is scarcely to be seen and all sorts of Grain is short, thin, pale and feeble while the Flax is quite dead’.³⁷ The most immediate concern was for the farm animals which resembled ‘walking skeletons’³⁸ according to Adams. Deprived of a supply of fodder for the winter, most would have to be slaughtered with long-term consequences for agricultural production.

France seems to have borne the brunt of the drought and with officials warning of the probable loss of between a half and three-quarters of all stock, ministers and bureaucrats swung into action. The advice of the Royal Academy of Sciences was sought, restrictions on free grazing in royal and ecclesiastical forests were lifted and in June a crisis committee of agricultural experts was set up at the heart of government. Although there was no gainsaying the immediate threat to animal husbandry and the food supply, ministers were determined to use the climatic conjuncture to re-launch the policy of agricultural reform from above which had marked time since the late 1770s. On behalf of the savants Lavoisier advised that it was not too late to plant maize which could then be cut green and fed to stock. Improving landowner as well as chemist, he was personally touched by the crisis when two of his tenant farmers defaulted on their rent payments. Controller General Calonne ordered the publication of the advice throughout the kingdom and instructed officials to distribute subsidized turnip seed to farmers. The seed had been procured from Britain through the good offices of Sir Joseph Banks, president of the Royal Society.

There was also some hope in government circles that the edible potato might come to the rescue of the poor as the drought cut back cereal crop yields in much of the kingdom. Antoine-Augustin Parmentier had been campaigning for the

³⁶ John A. Kington, ‘Daily Weather Mapping from 1781: a Detailed Synoptic Examination of Weather and Climate during the Decade Leading up to the French Revolution’, *Climatic Change*, 3:1 (1980), 24.

³⁷ Julian P. Boyd (ed.), *The Papers of Thomas Jefferson*. 24 vols. (Princeton, NJ, 1950–90), xviii, p. 159.

³⁸ Boyd, *The Papers of Thomas Jefferson*, xviii, p. 161.

introduction of the potato to the national diet since the 1770s, and had finally persuaded the king to take his proposals seriously. Sensing an opportunity he arranged in 1785 for a trial planting of potatoes in a two-hectare field just outside Paris. In the meantime, though, agriculture and animal husbandry had become the very epitome of courtly fashion quite independently of the effects of the drought. Louis XVI wore a potato flower in his button-hole while Marie-Antoinette took pleasure in dressing as a shepherdess in her own private retreat in the park of Versailles. In 1786 the king purchased a flock of merino ewes and rams from his cousin Carlos III of Spain and installed them at the royal sheep farm in Rambouillet. The fashion climate would soon alter, of course. As for the potato it would be several decades before the tuber entered the human food chain on a large scale in France, notwithstanding the fact that the monarch had labelled it a most 'useful plant'.³⁹ The Rambouillet farm on the other hand went from strength to strength and became a major centre of experimental breeding and diffusion of best practice animal husbandry (see p. 131).

The Administrative Committee on Agriculture called into being by the circumstance of the 1785 drought met regularly for two years. Like all such bodies, whether in France or elsewhere in Europe, it steadily enlarged its remit and started to make recommendations that had nothing whatsoever to do with the impact of the climate or the seasons. In 1787 Lavoisier, a founder member, submitted a report that attributed low agricultural yields to systemic institutional blockages (swingeing taxes, seigniorial surplus extraction, the church tithe, mill monopolies, labour service on the highways, and the re-introduced ban on grain exports). This was scarcely welcome reading for a government which was about to lose political control of the reform process. Maximilien de Lazowski was also a member and it is likely that his lengthy memorandum comparing France's agriculture with that of England to which we have already alluded proved uncomfortable reading as well. Yet, when revolution came to France in 1788–89 the agricultural reform agenda was carried over from the *ancien régime* more or less unaltered.

As an indication of their intentions the deputies of the National Assembly set up a Committee of Agriculture and Commerce in the late summer of 1789 with two main objectives: to free the soil and to free the marketplace. Although the extreme caution of the old government in both of these spheres should have given pause for thought, it was widely assumed that the 'regeneration' of agriculture would proceed at the same speed, or only a little behind the 'regeneration' of the nation's political life—that is to say very nearly instantaneously. When this failed to happen, a convenient myth was substituted which linked the renewal of agriculture to the abolition of the seigniorial regime in 1789–90, as though the rare cases of quasi-servility and the persistence of feudal relationships in the countryside were the only productivity constraints on the rural economy. Even today this misleading rhetoric is apt to confuse historians.⁴⁰ In reality, the revolutionaries were scarcely

³⁹ Becchia, *Modernités de l'Ancien Régime*, p. 63.

⁴⁰ Thus Jean Boulaine writes 'la période révolutionnaire, de 1789 à 1795, a entraîné une mutation sans équivalent dans l'histoire de notre pays, et qui est particulièrement importante dans le domaine agricole' *Histoire de l'agronomie en France*, 2nd edn. (Paris, 1996), p. 227.

more successful in finding solutions to the fallow, enclosure, the tenacity of common rights, the partition of common land, and the brevity of leases than were their predecessors of the bureaucratic monarchy. The codification of rural law leading to the construction of a 'rational' agriculture—a key aspiration of all enlightened agriculturalists—continued to elude them and so did a remedy for the fragmentation and dispersal of farm land holdings.

As an outside observer with a predilection for political reform Arthur Young reserved judgement on the agrarian achievements of the French revolutionaries as we have seen. Only the decision to abolish the tithe drew unstinted praise as his *Travels in France* went to press in 1792. However, his limited endorsement of their work was tinged with alarm that crowd pressure now threatened to undo enclosures carried out under the permissive edicts and 'declarations' of the old monarchy. It is true, if scarcely surprising, that the revolutionaries made very heavy weather of their agricultural legislation once the 'regenerationist' optimism of 1789 had begun to fade. The jurists among the legislators considered 'universal rural laws'⁴¹ an utterly unrealistic proposition in any case, and only in 1791 was a compromise package rather hurriedly agreed and voted upon. The land of France was duly proclaimed to be free 'like the persons who inhabit it'⁴² which therefore meant that owners enjoyed an unrestricted right to enclose and to grow whatever crops they pleased. However, the revolutionaries drew back from legislating out of existence collective rights such as stubble-grazing (*vaine pâture*) and inter-commoning (*parcours*) on the grounds that they formed part of the 'patrimony of the poor'⁴³ along with gleaning. In 1805 an anonymous official of the Ministry of the Interior would comment that the attempt by the revolutionaries to construct a viable policy of agricultural interventionism 'has brought little change to the old [regime] legislation'.⁴⁴

This is not to suggest that the French Revolution made no impact on the rural economy. Rural laws, however modest and cautious in their scope, were only one facet of the transformation effected in the lives of landowners and farmers between 1789 and 1815. Abolition of the game laws certainly altered the economics of agriculture and improved greatly the yields in the vicinity of the royal parks inasmuch as pests (deer, rabbits, and pigeons etc.) preying on the crops were quickly wiped out and farmers discovered that they could now afford to sow seed (grain, pulses) less densely. Land reclamation by the poor increased dramatically, too, on the basis of the political claim 'that the waste belonged to the nation',⁴⁵ and it has been suggested that the clarification of property rights allowed public-interest irrigation and drainage schemes to go ahead that would have been extremely difficult to undertake prior to 1789.⁴⁶ With state direct taxation declining significantly after 1791, a measure of well-being descended on the countryside the like of which

⁴¹ See Peter M. Jones, *The Peasantry in the French Revolution* (Cambridge, 1988), p. 131.

⁴² Decree of 5–12 June 1791.

⁴³ Decree of 12–20 August 1790.

⁴⁴ See Jones, *The Peasantry in the French Revolution*, p. 132.

⁴⁵ *Arthur Young's Travels in France*, p. 291.

⁴⁶ Jean-Laurent Rosenthal, *The Fruits of Revolution: Property Rights, Litigation and French Agriculture* (Cambridge, 1992).

had not been seen for a generation. Enhanced consumption was the main result, but contemporaries also noted renewed activity in the land market and improvements to farm infrastructure. Restocking took place and the thatch of many a cottage gave way to roof tiles.

With the onset in 1792–93 of war in a context of civil emergency at home the balance-sheet became less favourable, however. Arthur Young likened the France of the Terror to the Republic of Sparta, that is to say a ‘command’ economy presided over by the appropriately named Committee of Public Safety whose sole mission was to keep the armies supplied with manpower, *matériel*, fodder, and foodstuffs.⁴⁷ Prices were controlled, thus terminating the brief experiment with free markets, while commodities required for the war effort (grain, forage, flax, hemp, vegetable oils, brandy, rope, metals, etc.) were made liable to requisition. Agriculture suffered at once from a shortage of labour, from a shortage of wrought iron for agricultural implements (notably plough coulters, pruning hooks, and sickles) and from the requisition of draught animals. Fixed prices discouraged market participation, experimentation with new crops and rotations, and agricultural product specialization at a time when national survival was considered to depend above all else on the planting of bread grains. Enclosure became virtually unenforceable. The Committee of Public Safety recognized the conflict of policy objectives, but could only offer palliatives for as long as the country faced a threat of invasion. Simply phrased agricultural manuals were distributed *en masse* including a part-translation of Young’s own *Travels in France*,⁴⁸ key agricultural sectors were propped up with subsidies, and skilled workers in areas such as animal husbandry allowed to return home early from the front. Nevertheless yields plummeted, if only because land went out of cultivation for want of labour to till it. Yet this episode, which was relatively short-lived, did nothing to puncture the myth that the institutional dismantling of the seigniorial regime between 1789 and 1793 had released agriculture from its shackles.⁴⁹

The direct impact of war and civil commotion on agriculture was not confined to France. Crop volumes declined in Saxony too during the years of revolutionary and Napoleonic conflict. The greatest damage was done in 1803–05 during the War of the Third Coalition and in 1812 when substantial amounts of manpower were withdrawn from agriculture following the mobilization of the Saxon army to participate in Emperor Napoleon’s Russian campaign. Yet such titanic struggles could have unlooked-for benefits. Auguste Bella who in 1828 would become the first director of the Grignon school of agriculture, encountered the German agronomist

⁴⁷ ‘An Idea of the Present Agricultural State of France [...] By the Editor’, *Annals of Agriculture*, 23 (1795), 274–94.

⁴⁸ Jones, ‘Arthur Young: For and Against’, 1111–12.

⁴⁹ Whilst subscribing to this myth in his capacity as Minister of the Interior, François de Neufchâteau’s verdict was carefully phrased: ‘La révolution a tout fait pour l’agriculture, car elle a écarté les principaux obstacles qui entravaient l’essor de ce premier des arts; mais ceux qui cultivent ne sont pas toujours éclairés. Il faut répandre la lumière. Le trèfle est encore inconnu dans une partie de la France. Les funestes jachères stérilisent encore un tiers de ce grand territoire’, *Recueil des lettres circulaires, instructions, programmes, discours et autres actes publics émanés du C^{en} FRANÇOIS (de Neufchâteau)* (Paris, an VII), p. 8.

Albrecht Daniel Thaer as a result of the Hannover campaign of 1802–03. In poor health and confined to Celle, he was able to spend two years studying at Thaer's training institute. Decades earlier a similar circumstance had made Parmentier aware of the nutritional value of the potato. Taken prisoner during the Seven Years' War he observed that the Hanoverians and the Prussians used the tuber as a basic feed both for farm animals and enemy detainees. War both launched and ended military careers and those whose careers it ended often retired to their estates where they occupied themselves with agricultural improvement. The naturalist P.-T. Marcel de Serres who was commissioned to compile a statistical survey of the Austrian monarchy for the French army of occupation in 1809–10 specifically noted this phenomenon. Enforced idleness and penury had conspired to turn 'many a bearer of an illustrious name'⁵⁰ into an improving landlord, he observed.

The unspectacular but undoubted progress made by the Habsburgs in their German and Czech lands towards the eradication of personal serfdom and the establishment of a peasant class with secure possession is easily overlooked. It is true, however, that labour service remained an issue that no one in power or in office was prepared to tackle after the death of Joseph II and in the lurid light of events in France. Nevertheless, the Prussian reformer Karl Freiherr vom Stein was greatly impressed by what he found when forced into exile in Austria in 1809: 'here in the Austrian monarchy infinitely more has been done for the peasant than in Prussia', he told a correspondent. 'Bondage to the soil was abolished on November 1, 1781, as were all grain and mill restrictions. Only those concerning liquor licenses remained. In each district lawyers for the peasantry are employed. With the exception of Hungary and Galicia, the peasants are owners. Your Honour will realise how backward Prussian agrarian legislation is compared to the Austrian'.⁵¹

Prussia accepted the necessity of State intervention in the agricultural sphere under duress. Napoleon's victories at Austerlitz (1805) and Jena-Auerstedt (1806) demonstrated for all the world to see that the institution of enlightened absolute monarchy was no match for a renovated post-revolutionary State. There can be no doubt that structural change would have occurred sooner or later, though. After all, the future Frederick William III was known to favour agrarian reform unlike his father, and on his accession in 1797 he gave notice of his intentions with a measure to abolish serfdom on Crown estates. Rapid population growth in Prussia's eastern provinces was steadily mining the manorial economy from within in any case and as William Hagen has shown, estate farming in Brandenburg could be both productive and innovative without any need for action by government.⁵² Nevertheless, it was defeat on the battlefield that administered the shock which brought the liberal-minded ministry headed by Stein to power. Advice was sought from Albrecht Daniel Thaer, Germany's chief advocate of rational agriculture, and even from individuals with direct experience of French Revolutionary reform

⁵⁰ Link, *The Emancipation of the Austrian Peasant*, p. 172.

⁵¹ Link, *The Emancipation of the Austrian Peasant*, pp. 169–70.

⁵² William W. Hagen, *Ordinary Prussians: Brandenburg Junkers and Villagers, 1500–1840* (Cambridge, 2002), pp. 313–33, 649.

practices. The outcome was an edict promulgated in October 1807 which launched the process of abolishing serfdom and another in 1811, known as the edict of regulation, which offered the prospect of both hereditary peasants and tenants-at-will becoming owners of their holdings, albeit with a considerable land sacrifice to their erstwhile lords.

The agrarian imperatives lying behind these and other reforms are unmistakable. Fired by the example of England and the arguments of Arthur Young and Adam Smith, ministers hoped to bring into being a class of prosperous non-serf farmers similar to that existing in Prussia's Westphalian territories (Cleves, Mark). With their productive energies liberated by measures promoting enclosure and land consolidation, such farmers would become the future engine of growth. But first it was necessary to place everybody on the same legal footing and to free up the land market—hence the emancipation edict which put an end to the feudal bond with effect from 1810. In common with reformers nearly everywhere in Europe, Prussia's liberals acknowledged that the transition they envisaged would result in social casualties as the manorial economy made way for a more differentiated society of independent peasant producers, agricultural wage earners, and rural artisans. There was also the risk that landlords might emerge as the main beneficiaries of an unlimited power to enclose—leading not to a rural economy contoured around 'yeomen' farmers but to the eradication of smallholdings in favour of large noble estates on the model of Mecklenburg or the Scottish Highlands. Government attempts to guard against this eventuality provoked complaints from estate owners who pointed out that they were entitled to do as they pleased with their land. In the event, though, neither of these scenarios came to pass. The war resumed before the legislation could take full effect, and with the final defeat of France the sense of urgency driving the reforms was lost.

THE AFTERMATH

Government attempts to modernize the rural economy in the decades during and after the Seven Years' War had been driven by a mix of fiscal and intellectual considerations, to which was added an increasingly desperate 'survivalist' tactic as Napoleon proceeded to roll up the map of Europe in the absence of credible military opponents. Institutional reform modelled loosely on the example of France seemed a price worth paying if it made monarchies like Prussia and Austria more able to withstand the might of France. As a result, when the conflict finally came to an end, Europe resembled a patchwork quilt of completed, uncompleted, and largely stillborn agrarian reform initiatives.

Take the sprawling State of Prussia which, as a victor in the struggle against Napoleon, had acquired fresh territory in north-western Germany including Saxony's agricultural provinces and a substantial part of North Rhine-Westphalia. The kingdom now embraced four distinctive agrarian regimes. In newly acquired Swedish Pomerania commercial demesne agriculture prevailed from which small-scale peasant farming had been banished in the second half of the eighteenth

century. Insofar as serfs had been liberated in this region (by Gustav IV), it was without land. East of the River Elbe Prussia's own reform edicts were in force and, where implemented, presupposed a surrender of land in return for legal emancipation. In the territories to the west of the Elbe, however, the disentangling of the manorial economy was proceeding mainly on the basis of monetary redemption of seigniorial rights rather than the sacrifice of land. Prussia's Rhenish and Westphalian territories, on the other hand, had been firmly under French jurisdiction before 1814. Here the residues of feudalism had been wiped away without any compensation paid to former seigniors whatsoever.⁵³

In practice Prussia's hurried adoption of the agrarian reform agenda does not seem to have made much difference, at least in the short term. As Stein implied, the emancipation edict of 1807 attracted attention more for what it failed to tackle: ex-serfs were still required to pay dues and perform labour service in the heartlands of Prussia whereas seigniors kept hold of their privileges and monopolies. Jerome Blum observes bluntly that 'it is unclear what the decree did abolish'.⁵⁴ The landlords fought a long rearguard action against creeping agrarian individualism in any case, and a subsequent edict of 1816 placed obstacles in the path of peasants who wished to commute seigniorial obligations and withdraw land from the manor.

The discontent that flared intermittently in consequence ensured that the regime never succeeded in drawing a line under the episode of 1807–11. Notwithstanding Albrecht Daniel Thaer's teachings, many landowners refused to subscribe to the idea that agriculture should be viewed as a money-making activity. It was a way of life and the foundation stone of the organic society which the Enlightenment and the French Revolution had done so much to undermine. Liberal bureaucrats in and outside government increasingly took the side of the semi-servile country dwellers, however. Potato and cereal crop failures in the mid 1840s and the growing realization that the peasantry could no longer be counted on to support the regime signalled that a resolution of the issues surrounding agricultural reform could not be delayed indefinitely. Two years after the Berlin revolution of March 1848 an edict finally completed the emancipation process.

It is perhaps to be expected that modern economic historians play down the role of institutional change when exploring growth trajectories in *vormärz* Germany. Agricultural development did not wait upon the thirty plus edicts it required between 1807 and 1850 to bring an end to the servile system in Prussia. Freehold possession and relief from labour service may have been way stations on the road to modernity, but they were not necessary and unavoidable stopping places. The relatively efficient, surplus-generating estate agriculture of the East Elbian lands owed its existence mainly to the fact of urban demand—not demand from Prussia's own soon-to-be industrializing towns in the Ruhr and the Rhineland but international demand. Cereals from this region reached the English market via the Baltic

⁵³ See Kopsidis and Wolf, 'Agricultural Productivity across Prussia during the Industrial Revolution: a Thünen Perspective', 634–70.

⁵⁴ Blum, *The End of the Old Order in Rural Europe*, p. 387.

ports and in 1805 constituted nearly half of all the grain imported into Great Britain.⁵⁵ More localized agricultural economies supplied the food needs of the Ruhr population and for Westphalia, at least, the evidence suggests that it was the market which provided the spur to specialization and productivity gains.⁵⁶ However, this process was only just beginning in the 1830s and in a land-locked region it was heavily reliant on improvements to the transportation infrastructure. 'Top-down' agrarian reform resumed in Westphalia in 1829 with the application of the Prussian legal framework for the extinction of seigniorial dues, but it seems unlikely that this made much practical difference on the agricultural front for as we have noted the property rights of the Westphalian peasantry were already secure.

The rulers of Saxony had reason to be nervous of rural unrest as the business of peasant emancipation dragged on unseasonably into the early nineteenth century. There had been major anti-seigniorial disturbances in 1790 which caused alarm throughout Germany given the shadow cast by events in France. Although the type of manorialism in force in Saxony was not particularly onerous and does not appear to have hindered agricultural growth significantly, there remained areas of friction linked to animal husbandry. Sheep numbers doubled between 1779 and 1834 following the successful inbreeding of Spanish merinos with local flocks and a highly profitable raw wool export industry had developed.⁵⁷ Noble landlords defended vigorously their seigniorial grazing rights over common and fallow land in the face of protests from peasant farmers and efforts by the royal bureaucracy and judiciary to broker voluntary agreements that would extinguish such rights in return for monetary payment. When the chill wind of Paris-inspired revolution was felt again in 1830–1, the aged ruler of Saxony moved swiftly to liquidate what remained of the seigniorial regime. An edict of 1832 justified government intervention on the ground that impositions on peasant farmers 'hinder the free development of agricultural activity and damage one of the chief sources of national wealth'.⁵⁸

Fear that the insurrections against recently restored monarchs in Paris and Brussels might be the prelude to further uprisings across the Rhine brought concessions in Hannover as well. Here the edifice of seigniorial authority had already been toppled once—in 1807—following the French occupation. However, the disintegration of the Napoleonic Empire in 1813 enabled a semblance of the old order to be reinstated. Noble landowners resisted pressure from liberals for reform throughout the 1820s, and only when the news came through of the expulsion of Charles X of France did the government accept the need for decisive action. A programme of agrarian renewal was laid before the re-convened Diet which

⁵⁵ Marion W. Gray, *Prussia in Transition: Society and Politics under the Stein Reform Ministry of 1808* (Philadelphia, 1986), p. 25.

⁵⁶ Kopsidis and Hockmann, 'Technical Change in Westphalian Peasant Agriculture and the Rise of the Ruhr circa 1830–1880', 209–37.

⁵⁷ Michael Kopsidis and Ulrich Pfister, 'Agricultural Development during Early Industrialization in a Low-Wage Economy: Saxony, c.1790–1830', *EHES Working Papers*, 39 (June 2013), 11.

⁵⁸ Blum, *The End of the Old Order in Rural Europe*, p. 369.

resulted in William IV's decree of 1831 declaring that it was in the interest of 'the advancement of agriculture'⁵⁹ that all seigniorial privileges and obligations be abolished forthwith. A local revolution triggered by events in France and Belgium also speeded up reform in the Duchy of Brunswick. Legislation abruptly introduced in 1834 brought forward the business of dissolving the legal bonds between lords and peasants, the parcelling of common lands, and provided bank support which would enable peasants to meet their redemption payments.⁶⁰

Unlike Hannover, or for that matter Brunswick, the south German states tended to jump at agricultural reform before they were pushed into it. The rulers of Baden began the process of removing seigniorial controls over the rural economy as early as 1783, whereas in Württemberg the accession of William I in 1816 produced a complete change of direction leading to the creation of a constitutional monarchy. Seigniorial restraints on the ownership and use of land were removed the following year as part of an economic plan to bring about the recovery of the kingdom following the famine of 1816–17. The establishment in Hohenheim of an Agricultural Academy (see p. 179) in 1818 formed part of this response.

In the 1820s the king of Württemberg sent an agent over to London to arrange for the purchase of breeding specimens of Devon and Hereford cattle and the collection of the latest information on cropping practices and rotations. Legal emancipation of country dwellers was only the beginning and despite long-winded proclamations extolling the benefits for agriculture, most reformers had grasped by this time that the sluggishness of the rural economy was not to be remedied by the abolition of manorialism alone. The persistence of common rights over the unenclosed open-fields of Europe posed a formidable challenge to agricultural improvement. Although stubble grazing and pasturing on meadows after the first haying were rights all too easily exploited for commercial purposes by noble landlords, they were in fact rights vested in the collectivity, that is to say in the rural community. Therefore their extinction could only be achieved by the physical remodelling of village habitats as happened in Denmark and Sweden (see chapter eight), or by private negotiation. As we have seen in the case of France both before and after the political watershed of 1789, legislators were extremely cautious when venturing into this area. Even a century after the Revolution the practice of stubble grazing (*vaine pâture*) remained part and parcel of the open-field environment of northern France.⁶¹ In Prussia, it is true, an attempt was made to express the value of common rights in monetary terms with a view to their redemption, but only in the Austria did a government attempt (in 1848) to abolish them without compensation. The attempt failed.⁶²

⁵⁹ Blum, *The End of the Old Order in Rural Europe*, p. 369.

⁶⁰ Andreas Kulhawy, 'Financing the Agrarian Reforms and Promoting the Modernisation of Farming in 19th Century Germany: The Example of the Duchy of Brunswick', in Nadine Vivier (ed.), *The State and Rural Societies: Policy and Education in Europe, 1750–2000* (Turnhout, 2008), pp. 77–94.

⁶¹ Laws of 1889 and 1890 allowed villages to retain free grazing on application to the prefect.

⁶² Blum, *The End of the Old Order in Rural Europe*, pp. 411–12.

When the king of Württemberg's agent (a certain Herr Schmidt) arrived in London from Stuttgart he was dismayed to learn from Sir John Sinclair that the Board of Agriculture acting as 'a common centre of communication between this country and foreign nations no longer exists'.⁶³ It had been dissolved in 1822 having long since lost its *raison d'être*. This was scarcely surprising since British governments never formulated a consistent policy on agriculture, preferring to leave the task of improving the rural economy to individual effort and enterprise. In so far as the Board ever acquired a function in government it had been to forecast the state of the harvest and to report on threats to the food supply during the French Wars. It campaigned for the passing of a General Enclosure Act in order to reduce farming costs and lift agricultural production and, during the dearth and high prices of 1800–01, it advised ministers on the import of rice and the cultivation of substitute crops such as the potato. After the ending of the conflict in 1814–15 the Board's activities reflected the general dislocation experienced all over Europe as States tried to reconcile the promotion of manufacturing industry and in due course free trade, with the need to protect landowners and the agricultural investments they had made from foreign competition.

Whether governments liked it or not, the markets were now in charge. After the climatic abnormalities of the years 1816–17 which resulted in a massive harvest failure and what has been aptly labelled 'the last great subsistence crisis in the western world'⁶⁴ grain prices plummeted all over Europe rendering the cultivation of huge swathes of arable land temporarily uneconomic. By the 1820s estates in Schleswig-Holstein were changing hands for as little as a quarter of their value at the start of the century. Many East Prussia landowners became insolvent and lost control of their estates to the mortgage bank.⁶⁵ To make matters worse nascent specialist agricultures such as sugar beet, the cultivation of which had developed in France particularly during the Continental Blockade, were almost snuffed out by the re-opening of the Atlantic sea lanes. C.-J.-A. Mathieu de Dombasle who invested large sums in beet cultivation and refining long before he achieved fame as the founder of the Roville experimental farm in Lorraine (see chapter seven) was bankrupted when cane sugar from the Caribbean re-entered the domestic market (see pp. 174–5).

Unsurprisingly, then, in the immediate aftermath of the Napoleonic Wars the 'corn question' eclipsed all other agricultural considerations in the minds of governments. All European countries introduced protective tariffs in an attempt to insulate home grain producers from the price fall in the decade following the war. Similarly, all States save for Spain removed their duties and started to liberalize their trade in agricultural products from the 1840s.⁶⁶ In Britain the price slide was

⁶³ *The Correspondence of the Right Honourable Sir John Sinclair, Bart. [...] in Two Volumes* (London, 1831), ii, p.372.

⁶⁴ John D. Post, *The Last Great Subsistence Crisis in the Western World* (Baltimore and London, 1977).

⁶⁵ Wilhelm Abel, *Agrarkrisen und Agrarkonjunktur: eine Geschichte der Land- und Ernährungswirtschaft Mitteleuropas seit dem hohen Mittelalter* (Hamburg and Berlin, 1966), pp. 216, 221.

⁶⁶ See Giovanni Federico, 'The Corn Laws in Continental Perspective', *European Review of Economic History*, 16:2 (2012), 166–87.

exacerbated by the bumper harvest of 1813 with cereal prices dropping by more than half between January of that year and December 1815.⁶⁷ However, the main cause of the problem seems to have been over-production as farmers continued to put more land under wheat than the domestic market could absorb. Only in the mid 1830s with structural changes involving different crops and a switch to live-stock production beginning to take effect did the malaise in the countryside start to ease.

⁶⁷ A. R. Wilkes, 'Adjustments in Arable Farming after the Napoleonic Wars', *The Agricultural History Review*, 28:2 (1980), 90.

3

Vectors and Agents of Knowledge Transmission

In 1797 the third edition of the *Encyclopædia Britannica* appeared in eighteen volumes. It contained an eighty-two page entry on the subject of agriculture which surveyed the extent of progress made by the century's end, mainly from the vantage point of the British Isles. Whilst the contributions of government and the institutional environment were not overlooked the author, who was probably the Scottish hack-writer and compiler James Tytler, declared:

It is not, however, to the exertions of public bodies excellent and honourable as they are that all our modern improvements in agriculture owe their origin. To the natural genius of the people have been added the theory and practice of all nations in ancient and modern times. This accumulated mass of knowledge has been arranged, divided and subdivided: and after passing the test of practical experiments the essential and most valuable parts of it have been preserved, improved and amply diffused in the works of Lord Kames, Mr. Young, Stillingfleet, Dr. Hunter, Anderson, Dickson, Ellis, Randall, Lisle, Marshal, Mortimer, Duhamel, Bradley, Kent, Mills and a few other writers upon this great art of rendering mankind happy, wealthy and powerful.¹

This chapter focuses on the supply of agricultural knowledge: where it came from, how it was packaged and accredited for use, and the channels through which it flowed towards its destination. Whether such knowledge actually reached the intended audience and the extent to which it was taken up and combined with practical 'know-how' in the productive processes of the rural economy will be examined in chapter four. Usable information pertaining to agriculture, it should be emphasized, was simply a sub-set of general Enlightenment knowledge. Its producers and purveyors rarely passed for specialists and, generally speaking, their commitment to material improvement was not confined to the topics of agriculture and animal husbandry. In contrast to certain species of craft and manufacturing knowledge, the generation and distribution of information about agriculture was considered by contemporaries to be an 'open' and 'polite', that is to say genteel activity. In his address to the London Board of Agriculture and General Improvement on the occasion of its inaugural meeting in September 1793 Sir John Sinclair insisted from

¹ Quoted in James E. Handley, *The Agricultural Revolution in Scotland* (Glasgow, 1963), p. 168.

the president's chair that 'jealousy'² had no part to play in the agricultural sector. He repeated the observation three years later at a moment when the war against revolutionary France seemed at last to be coming to an end: 'there can be no rivalry; for the Agricultural prosperity of one country can do no injury to another'.³

In the modern terminology of economists, therefore, freely circulating information and particularly agricultural information can be considered a public good, the chief characteristics of which were non-rivalry and non-exclusive access. Whether this was really the case is another matter. As we have noted in previous chapters, political economists viewed agriculture as one measure among several of the (military) strength of States. Yet men like Sinclair wished enquiry in the agricultural domain to be accorded the status of a natural science. Free exchange was one of the hallmarks of savant discourse and there seemed no reason why it should not apply also to the late eighteenth-century incarnation of the 'world-wide farming web'.⁴ As optimism about prospects for a truce in the conflict dwindled in 1798 the agronomist Comte Charles-Philibert de Lasteyrie wrote to Sinclair from Paris to reassure him that hostilities between their two nations notwithstanding, men of science could, and should, continue to communicate. He invited Sinclair to send over to France the latest works in English on agriculture and the rural economy.⁵

War did disrupt Agricultural Enlightenment as we shall see—chiefly because of the physical barriers it placed in the path of knowledge transmission. Yet Lasteyrie's intellectual argument largely withstood the pressures generated by the two decades of geo-political rivalry pitting Britain against France. At the height of the Continental Blockade in 1809 Sinclair made contact with his opposite number Nicolas-Louis François de Neufchâteau, then president of the Agricultural Society of Paris, in order to request the despatch from fortress Europe of samples of spring wheat. After a consultation with Emperor Napoleon Bonaparte who was on campaign in Germany, two hundredweight barrels of seed drawn from various corners of the Empire were duly despatched, together with François de Neufchâteau's latest pamphlet publication on cereal cultivation.⁶

The growth to maturity in the second half of the eighteenth century of Europe's knowledge economy has deep-seated origins. Some economic historians believe that precocious literacy offering large numbers of people access to printed sources of information provides the key. Whilst it is doubtless the case that Europeans had no priority claim to the invention of printing technology, the mass production of printed books and pamphlets does appear to have been a singular achievement of the countries of

² *Précis du discours du Chevalier Jean Sinclair, Baronet, président, aux Seigneurs Commissaires du Bureau Britannique d'Agriculture, assemblés pour la première fois à l'ouverture du bureau, le 4 septembre 1793* (London, 1793), p. 3.

³ *Communications to the Board of Agriculture on Subjects relative to the Husbandry and Internal Improvement of the Country*, vol. 1, parts 1–2 (London, 1797), lxxv.

⁴ Joan Thirsk, 'The World-Wide Farming Web, 1500–1800' in John Broad (ed.), *A Common Agricultural Heritage? Revising French and British Rural Divergence*, (*Agricultural History Review Supplement*, 2009), 13–22.

⁵ *The Correspondence of the Right Honourable Sir John Sinclair Bart.*, ii, pp. 137–8.

⁶ Archives Nationales [henceforth A. N.], Paris 27AP 1 Fonds François de Neufchâteau, dossier 5: correspondance avec Sir John Sinclair.

early modern Europe.⁷ Scholars attracted to the Great Divergence thesis have responded that East Asian countries possessed the ability to print books as well, but there demand was confined, and deliberately confined, to a small elite of bureaucrats and literati. In Europe the attempt by States to police effectively the spread of knowledge had largely failed by the end of the seventeenth century and guild-organized occupational groups no longer displayed much conviction in their efforts to control the flow beyond the pale either. In any case the useful knowledge in process of accumulation from the 1760s was often explicitly packaged so that it could be diffused far and wide. When in 1796 the Pictet brothers of Geneva launched their hugely influential *Bibliothèque britannique* periodical, they debated the pros and cons of open access to scientific knowledge in the very first issue. Half-knowledge, it had been put to them, was more harmful than ignorance itself. Nonetheless, they concluded that the useful and observational sciences should be made available and linguistically intelligible to anyone in a position to act on the stores of information they contained.⁸

It is true, of course, that literacy rates are hard to compute and even harder to compare in a meaningful way. Taken on their own they cannot sustain the argument that Europeans had embarked upon a uniquely promising path of development well before 1800. Counting signatures appended to marriage contracts is a flimsy basis on which to assume an instrumental capacity and perhaps a willingness to absorb print culture. In any case it is not entirely clear that late eighteenth- or early nineteenth-century farmers needed to access anything other than orally transmitted information touching upon the theory and practice of agriculture. Modern studies of productivity in the developing world suggest that farmers in possession of basic schooling produce more than those without, but only in conditions favourable to modernization—that is to say where market opportunities are present and crop improvements within reach.⁹

Yet literacy and education do seem to have weighed on the minds of eighteenth-century observers. The Duc de Liancourt was not alone in his belief that French tenant farmers made poor improvers because, in contrast to their English counterparts, they were largely unable to read.¹⁰ In Scotland where agricultural progress occurred at breakneck speed in the final decades of the eighteenth century (see pp. 154–60) it is well established that literacy played an important role in spreading the spirit of improvement among the Lowland tenantry. Sir Archibald Grant admitted in 1760 that ‘common farmers do not read’, but this no longer seems to have been true by 1780, or thereabouts, when another observer reported that ‘books on agriculture are now so universally read’. In 1816 Sinclair would congratulate Scottish farmers on their predilection for reading.¹¹

⁷ For an estimate, see Broadberry et al., *British Economic Growth*, pp. 151 figure 4.04, 154–5.

⁸ ‘Le principe d’UTILITE, qui sera notre boussole constant, ne nous permet point au reste de mettre toutes les Sciences sur la même ligne; l’Agriculture tient à nos yeux le premier rang, elle est aussi pour nous le premier des arts’, *Bibliothèque britannique*, 1 (1796), 6.

⁹ See Anders Nilsson, Lars Pettersson, and Patrick Svensson, ‘Agrarian Transition and Literacy: The Case of Nineteenth-Century Sweden’, *European Review of Economic History*, 3:1 (1999), 80–1.

¹⁰ La Rochefoucauld, Wolikow, and Ikni, *Le Duc de La Rochefoucauld-Liancourt*, p. 389.

¹¹ Heather Holmes, ‘The Circulation of Scottish Agricultural Books during the Eighteenth Century’, *The Agricultural History Review*, 54:1 (2006), 78.

USEFUL INFORMATION AND COMMUNICATION

In common with general works on the economy (see chapter one), the quantity of printed reading matter relating to agriculture and animal husbandry increased significantly in the second half of the eighteenth century. This observation appears to hold for most of the countries of Europe and for most languages. Contemporaries remarked on the phenomenon at the time and while we may share some of the scepticism of Voltaire¹² as to the real impact of books which farmers only occasionally read, there can be no doubt that published literature (treatises, pamphlets, and periodicals) constituted one of the principal vectors of Agricultural Enlightenment. In England the information flow began to build up momentum in the 1760s and reached a peak during the decades of continental war (1790s and 1800s). It would prompt the agricultural writer William Marshall to remark scathingly that in the 1760s and 1770s, 'anything that was published on the subject was read with avidity, no matter how frivolous, or ridiculously void of useful information it might be'.¹³ In Scotland the improvement deficit was much greater than in England and the main spurt of agricultural publishing started a little earlier.¹⁴ Nevertheless, the major works by Adam Dickson, Henry Home, and James Anderson all came out in the 1760s and 1770s and in most other respects the trajectory of growth followed that of England. Some idea of the market saturation achieved by 1776 can be gleaned from the preface to Home's *The Gentleman Farmer* which began with the cautionary sentence, 'Behold another volume on husbandry! exclaims a peevish man on seeing the title-page: how long shall we be pestered with such trite stuff?'¹⁵

In Sweden the expansion in agricultural publishing began in the late 1750s and early 1760s also, and it was influenced by the rise of 'utilist' philosophy. Press censorship hampered public debate in Denmark until 1770, which tended to confine the discussion of economic and agrarian issues to officially approved bodies and the policed medium of the prize essay competition (see pp. 163, 204). Nevertheless, about five thousand works on agriculture appeared in Denmark-Norway between 1750 and 1814, the majority having a strongly practical focus.¹⁶ In the German-speaking lands book production increased approximately tenfold between 1763 and 1805.¹⁷ The Easter catalogues of the Leipzig book fair, moreover, reveal quite clearly the shifting tastes of the reading 'public' that was now emerging from the

¹² 'Vers l'an 1750 la nation rassasiée de vers, de tragédies, de comédies, d'opéras, de romans, d'histoires romanesques... se mit enfin à raisonner sur les blés. On oublia même les vignes pour ne parler que de froment et de seigle. On écrivit des choses utiles sur l'agriculture, tout le monde les lit, excepté les laboureurs', Voltaire, M.-A. Goujon *Œuvres complètes de Voltaire*. Tome 7: *Dictionnaire philosophique* (Paris, 1817), p. 511.

¹³ Horn, 'The Contribution of the Propagandist', 320.

¹⁴ Martin L. Parry and Terry R. Slater (eds), *The Making of the Scottish Countryside* (London, 1980), figure 7.6; Holmes, 'The Circulation of Scottish Agricultural Books', 47.

¹⁵ Henry Home [Lord Kames], *The Gentleman Farmer: Being an Attempt to Improve Agriculture by Subjecting it to the Test of Rational Principles* (Edinburgh and London, 1776), p. vii.

¹⁶ Hildor A. Barton, *Scandinavia in the Revolutionary Era, 1760–1815* (Minnesota, 1986), p. 61 note 32.

¹⁷ David A. Kronick, *A History of Scientific and Technical Periodicals: The Origins and Development of the Scientific and Technical Press, 1665–1790* (Metuchen, NJ, 1976), p. 36.

shadow of the absolutist State. New titles with a utilitarian thrust (relating in other words to agriculture and the crafts) represented little more than 1 per cent of publishers' listed offerings in 1740, but rose to 5.2 per cent in 1780 and then 8.6 per cent in 1800. In the meantime the market share enjoyed by theological treatises fell away (from 38.6 per cent to 13.7 per cent), whilst works of jurisprudence listed in the catalogues declined from 12.9 per cent to 5.1 per cent of the total.¹⁸ Turning to France we find the same pattern. The boom decades for the production of agricultural literature were all situated after the mid-century point (the 1750s, the 1760s, the 1780s, the 1820s, and the 1840s). However, comparatively little interest was expressed in animal husbandry before the 1740s—an indication perhaps of the limited scale of the livestock industry since works devoted to veterinary medicine were remarkable by their scarcity before 1750 as well.¹⁹

The expansion in the intellectual market for printed material sustained a buoyant translation industry since the new reading public expected to read works of utility as well as works of fiction (above all novels) in the vernacular. Closed communities of knowledge bearers retreated, figuratively speaking, in the face of open communities of educated men and women practising the leisure art of extensive, even omnivorous literature consumption. Again, the Leipzig book fair catalogues hint at the trend inasmuch as Latin titles still made up 28 per cent of the total offer in 1740, but only 14 per cent by 1770 and a mere 4 per cent by 1800.²⁰ From mid-century, or thereabouts, German readers became impatient to have access to English-language texts in their native tongue, whether the English classics (above all Shakespeare and Milton), the more transient genre of the eighteenth-century novel, or the didactic works of Arthur Young, William Marshall, and the legion of Scottish writers on agriculture. The Easter fair of 1770 in Leipzig listed a half year's output which included forty translations into German from English and seventy-one from French. In 1800 the figures were seventy-nine and 107 respectively. Young's *Six Months' Tour through the North of England* (1770) began to appear in German under a Leipzig imprint in 1772, although readers would have had access to one of Young's lesser publications thanks to a review by Albrecht Haller in the *Göttingische Gelehrte Anzeigen* the year before.²¹

The German reading public may have had an advantage inasmuch as the University of Göttingen provided a gateway for English influence, not to mention a ready supply of bilingual translators by virtue of the personal union between Hannover and Great Britain. French elites seem only to have made a conscious effort to master the English language from around 1750, probably in response to England's growing presence in international commerce and politics. As English trade within Europe took off, the frequency of translation of economic works from

¹⁸ Michael North, *'Material Delight and the Joy of Living': Cultural Consumption in the Age of Enlightenment in Germany* (Farnham, 2008), p. 8; Lindenfeld, *The Practical Imagination*, table 1.

¹⁹ Florian Reynaud, *L'Élevage bovin: de l'agronome au paysan, 1700–1850* (Rennes, 2010), pp. 54, 56, 66.

²⁰ North, *'Material Delight and the Joy of Living'*, p. 10.

²¹ Martin, 'Pæns to Progress: Arthur Young's Travel Accounts in German Translation', in Stockhorst (ed.), *Cultural Transfer through Translation*, p. 310.

English into French rose dramatically as S. A. Reinert has observed.²² Although the marketplace could largely be relied upon to furnish English agricultural treatises in translation and specialist publishing houses such as Buisson and Huzard emerged to manage the trade, the State also played a role. When visiting Paris in 1786 Sir John Sinclair was impressed to learn from Louis-Paul Abeille, the long-serving Inspector General of Manufactures, that 'he had a number of persons under him, who were employed to translate any book which he thought might be of use to France, and it was afterwards printed and circulated at the public expense'.²³

The translation industry expanded to embrace periodicals as well, particularly later on in the century as the thrust of Agricultural Enlightenment veered in a more technical and scientific direction (see chapters five and seven). In 1790 one of Young's regular correspondents announced, 'Your Annals [of Agriculture], I hear, will be literally translated into German by one Riem in Silesia, a compiler of a great variety of œconomical works'. The correspondent went on to remark that such a venture was scarcely necessary since the abstracting, in translation, of the English agricultural periodical press was already well established in Germany.²⁴ Translators and abstractors were not simply passive transmitters of knowledge: they unhesitatingly rearranged and abridged the information they received whilst criticizing and commenting on it. The Swiss agronomist, Baron Benjamin Crud, who published a four-volume French version of *Thaer's Grundsätze der rationellen Landwirtschaft* between 1811 and 1816 took it upon himself to verify all of Thaer's calculations and to correct them wherever necessary. In some cases translation could pose considerable challenges, though. Many of the instructional writings of Arthur Young, Sir John Sinclair, Lord Kames [Henry Home], and Albrecht Daniel Thaer were rendered into Danish at the behest of the government notwithstanding the fact that the language lacked a technical vocabulary. All in all some 200 foreign agricultural books were translated into Danish.²⁵ The suggestion is sometimes made that language was a barrier to communication in the age of the Enlightenment, but on the evidence presented here this does not seem very likely.²⁶ On the contrary, the work of translation and the cultural exchanges and adjustments triggered thereby, amounted to a vector of knowledge transmission in its own right.

If the quantity of agricultural information offered to farmers evolved over time, so did the quality. Many of the early treatises belonged to the belles lettres genre as we have noted: they were neither written by persons with direct exposure to agriculture, nor were they intended for practical use. They were compiled by leisured landowners and householders from the comfort of their reading cabinets. Figure 3.1

²² Reinert, *Translating Empire*, figures 1:1, 1:5, 1:7, 1:11.

²³ *The Correspondence of Sir John Sinclair*, ii, pp. 93–4.

²⁴ *Annals of Agriculture*, 13 (1790), 536 'a scheme which P. Beckmann, at Göttingen, will think superfluous; as he has all along inserted the contents of your works in his Periodical (Economical Library)'.

²⁵ Janken Myrdal, 'Agrarian Literature in Scandinavia and in Britain, Ireland and North America during the 18th Century', (unpublished paper prepared for EURHO, 2013), p. 12.

²⁶ See Leonard Dudley, *Mothers of Invention: How Expanding Social Networks Gave Birth to the Industrial Revolution* (Newcastle upon Tyne, 2012), p. 182.



Figure 3.1. Idealized cabinet of an enlightened landowner

Source: *Der Hausvater* by Otto von Münchhausen, volume 1, 1766.

captures this outlook through the medium of German *Hausväterliteratur* (see chapter one). The activities of the fields are depicted at a distance through the study windows. Rural labour according to the caption constitutes the bedrock of the economic and political order: woe and misfortune be upon he who recognizes as much yet flees the plough.

The emergence of agronomy with its ambition to become a fully fledged science of agriculture at the century's end focused attention on the technical—the specialist manual rather than the 'encyclopædic' tome gathering up all agricultural knowledge since the time of the Ancients. Public events conspired to accelerate this trend: institutional reform of the sort discussed in chapter two raised specific questions relating to land management, drainage, fencing, and soil improvement—particularly in the Nordic States; the era of European political revolution raised

and then dashed confidence in instantaneous agrarian solutions; and wars and blockades focused attention on the food supply and surrogate crops. In 1796 the London Board of Agriculture put its weight behind the publication of 'books for use; not massy volumes on a variety of different subjects, beyond the income of the generality of the people to purchase, or their time to peruse'.²⁷ Earlier works were now re-packaged and given a more practical emphasis. Adam Dickson's *Treatise of Agriculture* dwelt on principles and the systematization of agricultural knowledge when first published in 1762, but the final revised edition (published posthumously in 1785) was more of a 'how-to' manual. Among other topics it contained advice on the winter feeding of cattle in recognition of the growing importance to Scottish farmers of the dairying and fat-stock industries.²⁸

The transition now underway spawned a wide variety of popular works: farmers' magazines, illustrated pamphlets providing step-by-step guidance on how to construct agricultural machines, instructional booklets distributed by seed merchants, even the *Kalender* and the almanac was pressed into service—no longer a 'receptacle of popular error' as one journal put it, but a vehicle of enlightenment.²⁹ There was also a perceptible move to de-pedestal the heroic figures of the early Agricultural Enlightenment, notably in post-revolutionary France and Italy. As a result of the liquidation of church and *émigré* estates many novice farmers now had a stake of sorts in the rural economy and, whether they asked for it or not, they were offered advice and instruction at a more rudimentary level. Authors such as Baron Rougier de la Bergerie used this opportunity to draw a line under the *ancien régime*, condemning the adulation accorded to Jethro Tull and Arthur Young—self-proclaimed experts who had 'decreed'³⁰ that England should provide the model for everyone else to follow. However, their counterparts in Italy would criticize French as well as English agrarian wisdom. The holder of the chair of agriculture at Bologna University, Filippo Re, who coordinated the agricultural survey of the Kingdom of Italy between 1809 and 1814 deplored those whom he referred to as 'Anglo-Gallo maniac agronomists'³¹ who supposed that no allowances for the diversity of agricultural environments needed to be made.

AGRONOMIC TRAVEL

In 1784 *Der Teutsche Merkur*, the German literary magazine edited by Wieland, remarked that 'in no other age in the [history of the] world did people travel as much as they do in ours, where travel has become a sort of epidemic.... Indeed, even the learned man of slender means leaves his writing desk and undertakes

²⁷ *Annals of Agriculture*, 26 (1796), 513.

²⁸ Handley, *The Agricultural Revolution in Scotland*, pp. 164–5.

²⁹ *Bulletin des sciences agricoles et économiques*, 3 (1825), 143.

³⁰ 'Les livres anglais sur l'économie rurale ont fait un mal infini à l'agriculture de la France'. Rougier de la Bergerie, *Considérations sur l'histoire*, p. 264.

³¹ See Rossano Pazzagli, 'From Private Initiative to State Intervention: The Origins of Agricultural Education in Italy', in Nadine Vivier (ed.), *The State and Rural Societies. Policy and Education in Europe, 1750–2000* (Turnhout, 2008), p. 231.

journeys, not far, to be sure, but at least excursions, often with the intent of offering the world his hastily gathered remarks, and thereby recovering the costs involved'.³² The peace treaty ending the American War had just been signed and the post-roads of Europe were heavy with the lumbering carriages of grand tourists and the cabriolets of gentleman travellers. English continental voyagers and their servants alone numbered 40,000 individuals between 1783 and 1787 according to the historian Edward Gibbon—himself an expatriate resident of Lausanne.³³ A similar rage to travel, visit, and explore had gripped Europe's intelligentsia in the aftermath of the Seven Years' War. Horace Walpole claimed that no fewer than 40,000 tourists passed through Calais between 1763 and 1765.³⁴ The phenomenon of 'epidemic' travel was again manifested in 1801–02 when the warring States of Europe briefly opened their frontiers (the Peace of Amiens), and more durably following the final cessation of the Napoleonic Wars in 1815.

Person-to-person interaction has long been accepted as an important vector of knowledge transfer by historians of technology. Indeed, in the case of 'tacit' knowledge physical mobility, whether of inventors, entrepreneurs, or skilled craft workers, was often the *only* way to guarantee that a new technology would be both transferred and successfully implanted in the host country. We will explore skilled labour mobility in the context of Agricultural Enlightenment in chapter five. However, gentlemanly travel as an effective mode of cultural exchange should not be overlooked: in the interval between the Seven Years' War and the coalitions against Revolutionary and Napoleonic France it hugely accelerated the velocity of knowledge diffusion in Europe. Oceanic and continental travel facilitated the physical transfer of plants and knowledge of cropping practices, but face-to-face contact also enabled networks of mutual cooperation and obligation to be built up which usually withstood the pressures of political events and persisted even when travel was no longer permitted, or had become too hazardous to undertake.

Agronomic travel, in common with scientific and technological travel in general, was no random activity tacked on to an ambition to visit tourist sites and pass time in good company.³⁵ 'Seeing, listening, collecting, writing'³⁶ were skills that required preparation, practice, and untold patience. Sir John Sinclair embarked on his tour of northern Europe in 1786 with over a hundred letters of introduction in his baggage. Whilst on the packet crossing to Sweden he drew up a detailed questionnaire touching on scores of matters relating to agriculture, commerce, government, and so on. This was no more than best practice for enquiring minds. In his *Essay to Direct and Extend the Inquiries of Patriotic*

³² North, *Material Delight and the Joy of Living*, p. 27.

³³ J. E. Norton (ed.), *The Letters of Edward Gibbon*, vol. 3: 1784–1794 (London, 1956), p. 33.

³⁴ Ian Inkster, *Scientific Culture and Urbanisation in Industrialising Britain* (Aldershot, 1997), p. 406.

³⁵ Göran Rydén, 'The Enlightenment in Practice: Swedish Travellers and Knowledge about the Metal Trades', in Göran Rydén (ed.), *Sweden in the Eighteenth-Century World: Provincial Cosmopolitans* (Farnham, 2013), pp. 63–86.

³⁶ Hans E. Bödeker, '"Sehen, hören, sammeln, schreiben". Gelehrte Reisen im Kommunikationssystem der Gelehrtenrepublik', *Paedagogica Historica*, 38:2–3 (2002), 505–32.

Travellers Count Leopold von Berchtold advised that travel could have only one aim: the gathering of useful information.³⁷ To this end he created a template consisting of a massive compendium of 2,443 questions grouped into thirty-seven sub-sections. The book was dedicated to Arthur Young whom he had visited on his return from France and considered to be the very model of the 'methodical' traveller and minute-taker. By this exacting standard Sinclair cut a rather paltry figure, although his tour and more especially his bundle of letters of introduction laid the foundations for a correspondence network which embraced over 1,500 individuals by 1793. Later on in life he softened somewhat in his approach, allowing that 'Amusement' might also be an acceptable purpose of travel, albeit one very much subordinate to the pursuit of information. 'Every nation', he wrote, 'has some part of its government,—some regulations in its system of laws and its police —some branches of its commerce,—some mode of cultivating the ground,—some new practices in gardening,—some new plants or fruits... that may be worthy of attention.'³⁸

Arthur Young thought so highly of the improving attributes of travel that he proposed to the London Society for the Encouragement of Arts, Manufactures and Commerce that they provide grants to defray the cost of agricultural touring. However, he also stressed the qualities of discernment and judgement. In his view the skill set of the enquiring traveller should include both a practical knowledge of agriculture and the intellectual capacity to make connections, as he put it in the preface to his *Travels in France*, 'between the practice in the fields, and the resources of the empire'.³⁹ As if penning a prospectus for his impending journey to France, he wrote that the travelling agriculturalist must possess the ability to turn farmers' local practices into useful knowledge, 'to assign the cause to the effect; and to convert scattered observations into science, by deducing effective principles from transitory operations'.⁴⁰ Yet he would not have disagreed with Sinclair that the well-prepared traveller could hardly have too many letters of recommendation. In conditions where parties were not personally known to one another, letters of introduction circulated like a species of moral currency. Within the networks that helped to move agricultural knowledge around Europe they signalled a presumption of social parity and a promise of gentlemanly trustworthiness.

Arthur Young's correspondence, a selection of which still survives, captures the scale of agronomic travel in the decades following the Seven Years' War. His English agricultural tour guides of the late 1760s and early 1770s were widely read on the Continent as was *Political Arithmetic* (1774), and it is clear that his Suffolk farm became a stopping place for those travelling in search of agricultural knowledge and advice. One of the first to pay a visit was the Polish-Lithuanian nobleman Ignaz Massalski, the Prince-Bishop of Vilnius, who explored East Anglia in the company of a go-between, visiting farms picked out by Young for the excellence of

³⁷ Leopold Graf von Berchtold, *An Essay to Direct and Extend the Enquiries of Patriotic Travellers*. 2 vols. (London, 1789).

³⁸ *The Correspondence of Sir John Sinclair*, ii, p. 355.

³⁹ *Arthur Young's Travels in France*, p. lvi.

⁴⁰ *Annals of Agriculture*, 5 (1786), 24.

their husbandry.⁴¹ In return for the hospitality shown him, Massalski sent Young a set of the physiocratic monthly *Ephémérides du citoyen*. Other noble landowners followed, notably the French peer and duke La Rochefoucauld-Liancourt (1784), Count Kalaskowski, another Pole (1786), and the Hungarian Baron Miklós Vay of Vaja who was one of the central European subscribers to the *Annals of Agriculture*. His gentlemanly visitors or their envoys often asked him to supply services as well. Thus Prince Potemkin relied on Young to take care of the practical arrangements when Catherine II agreed to finance the training in England of a group of Russian farmhands (see p. 115). Young also found farm stewards, both for the Duke of La Rochefoucauld-Liancourt in 1790 and in 1802 for Count Fyodor Rostopchin, the favourite of Tsar Paul I.

In fact, a visit to Arthur Young's Bradfield farm by Potemkin's agent, Georg von Trappe, in the 1780s very nearly resulted in the issue of an official invitation to emigrate to Russia.⁴² Apparently the Empress was only dissuaded from this course of action when her attention was drawn to caustic remarks which Young had made about Russian agriculture in the *Annals*. Young's tendency to be 'severe and sarcastical in his expressions'⁴³ quite often got him into trouble as the Leicestershire livestock breeder Robert Bakewell would note. Young seems to have called in on Bakewell's Dishley stock farm on several occasions. Like Bradfield, it attracted a regular flow of titled visitors: Russian princes, French dukes, minor German royals, and British peers, not to mention ordinary farmers, farm managers, and fellow stockbreeders. In June 1787 the Earl of Hopetoun and his agent came to view Bakewell's fodder crops and watered meadows, and he was followed by the Marquess of Graham who arrived at the same time as 'an Irish Gentleman largely concerned in the breeding way'.⁴⁴

The Danish government, in particular, actively encouraged agronomic travel. To judge from his correspondence Arthur Young started to receive enquiries in 1771, notably from the writer P. W. Edinger of Copenhagen who had just completed a tour of Europe and was now planning to round off his studies with botany in Uppsala, 'or that part which may be applied to husbandry'.⁴⁵ In 1787 Bakewell received a visit from an agent of the king of Denmark whose mission was to collect information about sheep breeds, and in 1797 the Danish economist Gregers Begtrup came to Bradfield during his tour of England. He would subsequently embark on a survey of Danish agriculture modelled on the County Surveys commissioned by the London Board of Agriculture. His son, meanwhile, was sent to Britain in order to improve his farming skills. In 1806 Begtrup notified Young that the Reventlow brothers (principals in the Danish agrarian reform programme) were planning on a visit and were looking forward to meeting him.⁴⁶

⁴¹ B. L. Add. MSS 35126 Massalski to Young, n. d. The go-between and facilitator was João Jacinto de Magalhães [Jean-Hyacinthe Magellan], the Portuguese savant resident in London, see Magalhães to Young, 19 August 1772.

⁴² B. L. Add. MSS 35129 Trappe to Young, 27 June 1805.

⁴³ See Robert Bakewell to George Culley, Dishley, 8 February 1787 in Henry C. Pawson, *Robert Bakewell Pioneer Livestock Breeder* (London, 1957), p. 107.

⁴⁴ Bakewell to Culley, Dishley, 30 June 1787 in Pawson, *Robert Bakewell*, p. 113.

⁴⁵ B. L. Add. MSS 35126 Edinger to Young, Uppsala, 5 December 1771.

⁴⁶ B. L. Add. MSS 35129 Begtrup to Young, Copenhagen, 7 April 1806.

ECONOMIC AND AGRICULTURAL SOCIETIES

In the second half of the eighteenth century the ethic of improvement found its most visible and expressive outlet in the plethora of economic, patriotic, and agricultural societies that mushroomed all over Europe. It is worth pausing to consider the notion of 'improvement' at this juncture because it was one of the bonds which held the aspiration to Agricultural Enlightenment together. At the most superficial level the word improvement translated the collective effort of landowners to extract the maximum economic benefit from their properties; an effort triggered usually by an awareness of expanding market opportunities. James Anderson, one of the Scottish agricultural writers to which the *Encyclopædia Britannica* article referred, made the point bluntly in 1777, 'I call that only an improvement in agriculture when any particular field is made to afford more sustenance to a man on an average of years than it did formerly'.⁴⁷ Yet there was much more to improvement than this bread-and-butter logic. Peter Borsay claims that it became the key element of the British Enlightenment and invites us to consider the mobilizing potential of improvement as a kind of 'super-concept' that 'may have been the dominant cultural trope of the eighteenth century'.⁴⁸

What symbolic meanings did the message of improvement convey when applied chiefly, albeit not exclusively, to the agricultural domain? It signalled the joining of the Enlightenment battle to banish superstition, custom, sloth, and torpor; it signalled a recognition of agricultural reform as a public as well as a private good; an acceptance of the proposition that mankind had a duty to exploit the natural resources of the land to their fullest extent. As Europe plunged into a long night of revolutionary experimentation after 1789, 'improvement' acquired quasi-redemptive qualities as well. In a book published in 1795 Archibald Cochrane, the ninth Earl of Dundonald, lauded the moral worth of agriculture as a prophylactic against 'foreign foes and domestic incendiaries'.⁴⁹ Whilst taking care to avoid a shrill and partisan tone, Arthur Young shared this outlook. An advertisement drafted apparently in 1801 on the occasion of the French edition of his collected works celebrated 'the moral bond of utility' in the conviction that it would overcome 'the transitory quarrels that disunite Nations'. Agriculture, he proclaimed, 'alone can heal the wounds occasioned by war'.⁵⁰ That said, however, 'agrarian patriotism'⁵¹ rooted in the practice of improvement could also be deployed as an ideology to consolidate the British State—whether in the aftermath of the American War, or during the long and exhausting conflict with revolutionary and Napoleonic France.

⁴⁷ Neil Davidson, 'The Scottish Path to Capitalist Agriculture 1: From the Crisis of Feudalism to the Origins of Agrarian Transformation (1688–1746)', *Journal of Agrarian Change*, 4:3 (2004), 423.

⁴⁸ Peter Borsay, 'The Culture of Improvement', in Paul Langford (ed.), *The Eighteenth Century, 1688–1815* (Oxford, 2002), pp. 184, 204.

⁴⁹ Archibald Cochrane, *A Treatise Shewing the Intimate Connection that Subsists between Agriculture and Chemistry* (London, 1795), p. 6.

⁵⁰ B. L. Add MSS W35128 'The English Farmer'.

⁵¹ See Nigel Leask, *Robert Burns and the Pastoral: Poetry and Improvement in Late Eighteenth-Century Scotland* (Oxford, 2010), pp. 37–42.

Although *Patriotismus* was not employed in this latter sense in German-speaking countries, the term nonetheless conveyed much that was common to the ethic of improvement as the Scots and the English came to understand it. The 'patriotism' of the *Aufklärung* implied a middling virtue of striving for the common good via forms of cooperative activity which might be learned, philanthropic, or utilitarian in their focus. It was much in vogue during the second half of the eighteenth century and found expression in the establishment of around two hundred private 'patriotic' or 'economic' societies. Thanks to the researches carried out by H. E. Lowood⁵² in the 1980s and the contextualization provided more recently by Koen Stapelbroek and Jani Marjanen⁵³ we can now appreciate more fully the role and significance of these independent bodies as vectors of Agricultural Enlightenment. Enthusiasm for improvement was chiefly a feature of the societies founded in the 1760s and early 1770s (around eighty-five creations). They promoted the application of useful knowledge to agriculture and craft industry in a 'hands-on' fashion that might involve experimentation and a certain amount of training of affiliates. The best known of these bodies was the *Oekonomische Gesellschaft* of Berne, founded in response to a dearth which coincided with the outbreak of the Seven Years' War. Members were expected to be active supporters of agricultural improvement and were actually examined on their knowledge of husbandry.⁵⁴ The society promoted the usual range of 'good causes' (plant and seed exchange, cultivation of artificial grasses and fodder crops, stall feeding of cattle, silk production, etc.) and undertook the translation of many key texts relating to agriculture, horticulture, and stockbreeding.

Whether the august and semi-official Berne Economic Society, which counted Young among its corresponding members, actually admitted practising farmers and craftsmen to its ranks is another matter though. It seems that it did not. Only the Saxon societies established in Leipzig and Oberlausitz made an effort to do so, although the Bavarian society of Altötting tried to reach out to local farmers and craftsmen and engage them to carry out experiments. Actual members had an obligation laid on them to complete an experiment, report an observation, or make a communication each year, and we find a similar practice operating in the Agricultural Society of Celle in Hannover. These were fairly transient arrangements, however, for Lowood notes that active 'improvement' was always an uphill struggle in Germany and enthusiasm soon waned as farmers failed to respond to the incentives offered to them. From the mid 1770s the thrust of what passed for agricultural improvement started to switch from rural interventionism to information gathering. Comparing the two periods 1765–74 and 1790–99 he finds that 'informing' activities increased from 18 per cent to 25 per cent over time whereas

⁵² Henry E. Lowood, 'Patriotism, Profit and the Promotion of Science in the German Enlightenment: The Economic and Scientific Societies, 1760–1815' (PhD dissertation, University of California, Berkeley, 1987).

⁵³ Stapelbroek and Marjanen (eds), *The Rise of Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*.

⁵⁴ Nobles and honorary members were exempted from the test, see Lowood, 'Patriotism, Profit and the Promotion of Science', p. 42 note 58.

'producing' activities (management of farms and gardens, beekeeping, etc.) declined from 12 per cent to 2 per cent.⁵⁵ By 1800 the German societies were chiefly absorbed in counting, cataloguing, and ordering knowledge in common with the *Kameralisten* discussed in chapter one. Even so, Lowood estimates that between 20,000 and 30,000 patriotic-minded Germans had been introduced to the theory, if not always the day-to-day practice, of agricultural improvement.⁵⁶

The Berne Economic Society had been modelled on the *Société d'agriculture, de commerce et des arts de Bretagne* founded in 1757. It was the forerunner of about twenty such societies set up in the French provinces. They were chiefly the product of a partnership between Henri Bertin, the long-serving physiocrat minister, and regional aristocratic elites. By 1779 most were moribund and all would be abolished during the Revolution. However, they started to reappear in force and with a clearer remit from central government in 1798, shortly after François de Neufchâteau was appointed Minister of the Interior. Most historians doubt whether these *ancien régime* creations did much to foster agricultural development: they moved knowledge around a restricted circle of affiliates and that was all. Martine Cocaud describes the relationship between the Breton Society and the Breton country dweller as one of 'mutual incomprehension'.⁵⁷ Even at the time there was considerable scepticism as to the value of such elite institutions. Charles Pictet de Rochemont suggested in the *Bibliothèque britannique* that improvement was unlikely to be accomplished by this route, commenting that in many parts of Europe a cynic might conclude that agricultural societies had come into being in order to provide support for the papermaking and printing industries.⁵⁸ The Paris-based body (*Société d'agriculture de la généralité de Paris*) founded in 1761 does seem to have defied the general rule of chronic inertia, however. Reinvigorated in 1783 by the election of Lavoisier and a number of other *académiciens*, it began to play a more conspicuous role and to publish memoirs containing useful instructions on, for example, the drought of 1785.

It is said that the inspiration for the agricultural society established in Brittany came from Ireland where a Society for Improving Husbandry, Manufactures and other Useful Arts had existed in Dublin since 1731. This is plausible since the two provinces had the linen industry in common; in other words a rural economy with a commercial focus on flax production, and they were in competition in international markets. It does seem that the Dublin Society was a prototype for the more empirical approach to improvement in Europe. Its regulations required each member, 'to choose some particular subject either in Natural History or in Husbandry, Agriculture or Gardening, or some species of Manufacture or other branch of improvement'⁵⁹ and to report back at meetings. Most unusually, from 1746 it

⁵⁵ Lowood, 'Patriotism, Profit and the Promotion of Science', p. 86.

⁵⁶ Lowood, 'Patriotism, Profit and the Promotion of Science', p. 65.

⁵⁷ Martine Cocaud, 'Des cadres pour la rénovation agricole: les sociétés d'agriculture en Ille-et-Vilaine en 1757–1880', in Michel Boulet (ed.), *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945* (Dijon, 2000), p. 199.

⁵⁸ *Bibliothèque britannique*, 3 (1798), 111.

⁵⁹ John Gascoigne, *Science, Philosophy and Religion in the Age of the Enlightenment: British and Global Contexts* (Farnham, 2010), p. 45.

received a measure of government financial support in recognition of its efforts to stimulate the economic growth of Ireland. The Dublin society was not the first utilitarian institution to come into being in the British Isles, though, for a Scottish Society of Improvers in the Knowledge of Agriculture had been founded in Edinburgh as early as 1723. From the outset its members acknowledged the need to reach out and make contact with those who actually tilled the soil. The sub-committee in charge of the Society's first publication were told to ensure that a 'familiar Stile' was employed, 'such as the Country Farmers might easily understand'.⁶⁰

This body was more significant as a pointer to the future than for what it actually managed to achieve at the time, given that Scottish agriculture was in the doldrums until the 1750s (see chapter six). After a couple of decades its remit was taken over by another Edinburgh-based creation: the Society for Encouraging Arts, Science, Manufactures and Agriculture. However, the most important institutional vector of Agricultural Enlightenment in Scotland, in the judgement of James Handley,⁶¹ would be the Highland and Agricultural Society founded in 1784–85. It secured a royal charter in 1787 and by the turn of the century membership had risen from thirty-nine to about 700 (1,400 by 1820). In command of considerable financial resources, the Society intervened actively to promote and disseminate improvements: water meadows, more efficient plough designs, machine technology for harrowing, reaping and so on. Compared with France or even with Ireland, Scotland's eighteenth-century population was tiny (c.1.6 million in 1801), yet it is reckoned that the country gave birth to around 130 agricultural improvement associations of one sort or another between 1723 and 1835.⁶² Since these multi-tiered creations, which ranged from bodies with a nation-wide influence to modest local farmers' clubs, raise important questions about the mechanisms of knowledge diffusion and take-up we shall return to them in chapter four.

Comparable developments occurred in England, but a little later and on a more restrained footing. Maximilien de Lazowski was not alone in noticing that late eighteenth-century England appeared to have much less of a need for organized groups of patriotic individuals in order to 'perfect'⁶³ the art of agriculture. Yet this was apparently not the case in Spain which saw the birth of around seventy economic-type societies in the period before 1815, or in the United Provinces (57), or Sweden-Finland (25), or Denmark-Norway (83).⁶⁴ The Royal Economic Society of Madrid (*Real Sociedad Económica Matritense de Amigo del País*) had been set up in 1775 following the intervention of the Conde de Campomanes. It was mandated to investigate agrarian conditions in Castile and to take forward the ministerial reform agenda. Although Campomanes' protégé Gaspar Melchor de Jovellanos

⁶⁰ Brian Bonnyman, 'Agrarian Patriotism and the Landed Interest: The Scottish "Society of Improvers in the Knowledge of Agriculture", 1723–1746', in Stapelbroek and Marjanen (eds), *The Rise of Economic Societies*, p. 38.

⁶¹ Handley, *The Agricultural Revolution in Scotland*, pp. 73–89.

⁶² R. C. Boud, 'Scottish Agricultural Improvement Societies, 1723–1835', *Review of Scottish Culture*, 1 (1984), 74–5.

⁶³ A. D. Oise 6Jp 14 'Etat de l'agriculture en Angleterre, folio 75'.

⁶⁴ Stapelbroek and Marjanen (eds), *The Rise of Economic Societies*, pp. 14–15.

would eventually submit an impressive report, it was not followed up with action on the ground.⁶⁵ Yet the Madrid government would return to the task of promoting reform from above in the conditions of near State bankruptcy consequent on the 1792–95 war with revolutionary France.

Denmark borrowed the model of the London Society for the Encouragement of Arts and Manufactures and Commerce when instituting its Agricultural Society in 1769. The private initiative of two Danes who had been enrolled as members of the London association, the Society soon obtained a royal charter. As the State's agrarian reforms got under way regional and district foundations came thick and fast, one of the first being the *Schleswig-Holsteinische Patriotische Gesellschaft* in Kiel. It adopted the motto 'the advancement of agriculture and civic welfare'.⁶⁶ The first patriotic society in Sweden was established in the aftermath of the Seven Years' War in 1766, while Russia's Free Economic Society for the Promotion of Agriculture and Household Management also held its inaugural session in that year. Once again, the theme of knowledge diffusion via travel emerges clearly inasmuch as it was a Russian diplomat, Count Jacob Johan Sievers, a resident of London when the Society for the Encouragement of Arts came into existence, who was instrumental in promoting the idea of an independent body to Empress Catherine II.⁶⁷

In 1809 Thomas Jefferson applauded the role played by the economic societies from the vantage point of Washington—probably the most distant outpost of Europe's Agricultural Enlightenment: 'these societies are always in peace, however their nations may be at war. Like the republic of letters, they form a great fraternity spreading over the whole earth, and their correspondence is never interrupted by any civilised nation'.⁶⁸

AGENTS AND INSTIGATORS

Is it possible to identify specific agents who were responsible for the transmission of agricultural knowledge? An influential viewpoint shared by many agrarian historians would question the very notion of prime movers and substitute instead a vision of a gradual development rooted in a process of 'contagion' whereby the actions of numberless, largely anonymous individuals combined to bring about change. This is an argument we will examine in chapter four when assessing what actually happened in Europe's farms and fields and, in so far as it is possible to know, how it happened. At this stage the hypothesis that certain individuals or groups of individuals among the educated were more influential than others in moving knowledge around and creating the potential for agricultural improvement needs to be fleshed out.

⁶⁵ Herr, *Rural Change and Royal Finances in Spain*, pp. 47–50.

⁶⁶ Barton, *Scandinavia in the Revolutionary Era*, p. 132.

⁶⁷ Joseph Bradley, *Voluntary Associations in Tsarist Russia: Science, Patriotism, and Civil Society* (Cambridge, MA, 2009), pp. 45–57.

⁶⁸ *Memoirs, Correspondence and Private Papers of Thomas Jefferson, Late President of the United States* edited by Thomas Jefferson Randolph. 4 vols. (London, 1829), iii, p. 127.

The role of the great publicists of Agricultural Enlightenment has already been invoked and need only be sketched again in outline. Contemporaries regarded Arthur Young as the pre-eminent communicator and commentator of the age. In 1816 the American agrarian democrat John Taylor remarked that, 'Arthur Young alone seems to me to occupy the station among agriculturalists, which Bacon does among philosophers. He makes records, and reasons with great perspicuity from a great variety of experiments. He was [*sic*] a practical farmer and a good writer. His works, under the title of annals, travels etc. are very extensive, and would alone, as they extend to about 20 octavo volumes, constitute a valuable agricultural library'.⁶⁹ The activist phase of Young's career was brought to a close by the total loss of his sight following a cataract operation in 1811. By that date he had travelled more than 20,000 miles in the cause of agricultural improvement and authored a stream of books and pamphlets which included a dozen volumes of tours relating to England, Ireland, France and Catalonia, a much translated work on political economy and a further forty-six volumes of agricultural journalism. The *Annals of Agriculture* had been launched in 1783 as a peacetime venture. By the time publication ceased in 1808 Young had contributed about a third of the articles published and cemented his fame across Europe as the most articulate propagandist for the modernizing rural economy.

Young's intellectual impact on prophets and practitioners of agricultural improvement on the Continent was relayed and extended by the Pictet brothers of Geneva and by Albrecht Daniel Thaer of Celle in Hannover. The Pictets have been viewed as pioneers of nineteenth-century science journalism⁷⁰ and their situation in Geneva, a town which Sismondi⁷¹ described as speaking in French but reading and thinking in English, gave them an unrivalled base of operations from which to combine and redirect the knowledge flows of the late Enlightenment. Marc-Auguste Pictet edited the 'science and arts' section of the *Bibliothèque britannique*, whereas his younger brother Charles took over 'literature' and 'agriculture'. Primarily a vehicle for the translation of knowledge from one linguistic zone to another, the journal widened its remit in 1816 when it was renamed the *Bibliothèque universelle*. However, Charles Pictet de Rochemont was also an improving gentleman farmer and agronomist in his own right. He converted a landholding in Lancy just outside Geneva into a model farm where he experimented with new crops such as maize and the potato, and raised pure-blooded merino sheep. It was he who alerted the non-German reading public to the activities of Emanuel Fellenberg on his estate of Hofwyl in the canton of Berne (see pp. 89–91).

In common with Pictet de Rochemont, Albrecht Daniel Thaer also had a track record of successful and productive farming. Trained as a physician, he had become

⁶⁹ Manuela Albertone, 'The American Agricultural Societies and the Making of the New Republic, 1785–1830', in Stapelbroek and Marjanen (eds), *The Rise of Economic Societies*, p. 342.

⁷⁰ David Bickerton, *Marc-Auguste and Charles Pictet: the Bibliothèque britannique, 1796–1815 and the Dissemination of British Literature and Science on the Continent* (Geneva, 1986), part 1, but see also I. P. Watts, '"We Want No Authors": William Nicholson and the Contested Role of the Scientific Journal in Britain, 1797–1813', *The British Journal for the History of Science*, 47:3 (2014), 397–419.

⁷¹ Hugues Jahier, 'Angleterre et Suisse Romande: étude sur le commerce européen au XVIII^e siècle'. 2 vols. (Thèse de doctorat d'état, Université de Paris IV Sorbonne, 1994), i, p. 448.

a member of the Celle Agricultural Society by 1784 and soon began experimenting and innovating on a garden plot outside the town walls, and then on a small farm not far distant. He regarded himself as a disciple of Young and copied his mentor in embarking on extensive fact-finding tours of northern Germany. The first volume of his distillation of English-language writings on agriculture and the rural economy (*Einleitung zur Kenntniss der englischen Landwirtschaft*) was published in 1798 although it would be another decade before his definitive agricultural treatise, *Die Grundsätze der rationellen Wirtschaft* (1809–12) appeared.⁷² By that date he had moved to Möglin near Berlin, of course, and was widely regarded as Germany's leading advocate of the principles of rational agriculture—a reputation that persisted until the 1840s when Justus Liebig burst onto the scene (see pp. 183–5). 'Rational' agriculture for men like Thaer, Young, and also Sinclair found fullest expression in the systematization of all aspects of husbandry and estate management. It acknowledged the role of science and more especially the startling progress being made in chemistry, but did not make the physical sciences the panacea for all the shortcomings of the rural economy.

Sir John Sinclair, Young's superior at the Board of Agriculture and Internal Improvement, probably merits inclusion in a list of principal agents as well—if only for the reason that his formidable stamina for the processing and distributing of agricultural knowledge persisted into the 1830s when the other protagonists had departed the scenes, or were no longer active. He published ten books in seventeen volumes and no fewer than 368 pamphlets including sixteen in 1835—the last year of his life. As we have already noted, his correspondence network grew to colossal proportions as he door-stepped the great and the good and then bombarded them with letters which very often contained unsolicited and not particularly welcome advice. He, too, would produce a compilation or 'code' of agricultural knowledge, in 1817. It ran through five editions and was translated by Mathieu de Dombasle into French as well as into German and Danish. However, his most substantial and enduring contribution to Agricultural Enlightenment was focused on Scotland: the launch and implementation of the [Old] *Statistical Account* or survey of all 893 parishes of his native land between 1791 and 1799.

The rural clergy appear frequently among the agents of Agricultural Enlightenment. They lived in close proximity to Europe's farmers and were well positioned to relay information and requests, whether from government bodies or the free agricultural societies. Indeed, there is some evidence to suggest that such societies recruited clerics into their ranks as proxies or surrogates for the practising farmers whom they could not, or chose not to attract. In many parts of Europe the clergy acted as village schoolmasters or else managed schools which provided a further opportunity for knowledge diffusion. It should not be forgotten, either, that priests and pastors generally possessed glebe land upon which they could experiment and innovate. Among the members of the Comité d'agriculture set up

⁷² For Thaer's own account of his agricultural apprenticeship, see *The Principles of Practical Agriculture* by Albert D. Thaer; translated by William Shaw and Cuthbert W. Johnson (New York, 1856), pp. iii–ix.

in Versailles in response to the drought of 1785 was the *abbé* Lefebvre, administrator of the Order of St Geneviève. He volunteered to arrange for the distribution of the circulars of the Comité through the network of his Order's 110 houses and 610 *prieur-curés*.⁷³ Sinclair, in turn, relied heavily on the mobilizing capacity of the General Assembly of the Church of Scotland in order to compile the *Statistical Account*.

Lutheran clergy were heavily represented in the Finnish Economic Society established in 1797, principally in the role of 'corresponding' members attached to rural parishes, and we find a broadly comparable situation obtaining in Sweden, Denmark, and several of the Swiss cantons. In Hannover the Celle Society extended its reach with branches known as *Cantons-Gesellschaften* which recruited many rural clergymen. In Bavaria analysis of the membership lists of the Burghausen Society reveals a clerical presence of around 18 per cent.⁷⁴ Innovating pastors were sometimes referred to as 'potato priests'⁷⁵ in the Scandinavian lands—a reference no doubt to the experimentalist inclinations of a Pietist-influenced clergy and their proselytizing zeal. Clover cultivation was pioneered on the glebe of the vicarage of Vaer in Jutland (Denmark) in the 1770s and we know that the incumbent possessed a number of books on husbandry as well.⁷⁶ The same applied in Sweden. Pastors sometimes purchased works on agriculture or stock-raising for inclusion in parish libraries.⁷⁷ In France the Duc de Liancourt would enlist the support of the parish priests of his marquise in order to encourage local farmers to adopt a new practice relating to first haying. In matters to do with agriculture the duke was an eternal optimist. Four years earlier, in 1782, he had had to compensate a tenant farmer after a disastrous cropping experiment agreed to by his father on the advice of a self-appointed agronomist, the *abbé* de Bruxelles.⁷⁸

As for Spain, government ministers would specifically target parish priests for the role of agents and instigators of Agricultural Enlightenment. After all, the Conde de Campomanes had anticipated their enlistment in his *Discourse on the Encouragement of Popular Industry* (1774). Several of the Iberian economic societies were largely made up of clergy in fact (Seville, Málaga, Jerez de la Frontera), and in 1797 a Magazine of Agriculture and Arts for Parish Rectors (*Semanario de Agricultura y Artes dirigido a los Párrocos*) was launched. The rectors, it was envisaged, would gather data on agriculture and rural industry and transmit it to the

⁷³ Pigeonneau and Foville, *L'Administration de l'agriculture*, p. xviii.

⁷⁴ Hans E. Bödeker, 'Economic Societies in Germany, 1760–1820: Organisation, Social Structures and Fields of Activities', in Stapelbroek and Marjanen (eds), *The Rise of the Economic Societies*, p. 192.

⁷⁵ Blum, *The End of the Old Order in Rural Europe*, p. 290.

⁷⁶ Kjaergaard, *The Danish Revolution*, p. 255.

⁷⁷ Janken Myrdal, 'Agricultural Literature in Scandinavia and Anglo-Saxon Countries, c.1700–1800 as an Indicator of a Changed Mentality', p. 3, <http://www.kuleuven.be/icag/files/MyrdalLeuven2014.pdf> (accessed 15 March 2015).

⁷⁸ A rebate on the rent of 400 *livres* was agreed, 'en indemnité de la perte que nous ont causée les labours, défrichements et semences de 50 arpents de blé à la méthode de l'abbé de Bruxelles, lesquels n'ont point réussi', see La Rochefoucauld, Wolikow, and Ikni, *Le Duc de La Rochefoucauld-Liancourt*, p. 107.

economic societies as part and parcel of their mission to 'enlighten' the peasantry.⁷⁹

To be sure none of this indirect evidence actually demonstrates that the clergy performed successfully the role of cultural intermediary and agent of Agricultural Enlightenment. Anxieties over the yield of the tithe (likely to diminish when farmers switched arable land to fodder crops or grass) must have tempered enthusiasm for the new husbandry. In Spain we know that very few parishes took out subscriptions to the *Semanario de Agricultura*.⁸⁰ Yet the phenomenon of the trail-blazing farmer-priest occurs too frequently in the sources to be ignored. One of the best documented examples is the case of Jean-Frédéric Oberlin who was appointed pastor of Waldersbach in the Vosges (Alsace) in 1767. He converted his presbytery garden into an agronomic trial-site and devoted more than fifty years to the task of nudging the peasant cultivators of his neighbourhood in the direction of improved agricultural practices. Within the modest confines of a highland parish he set up a lending library, a shop, a credit union, a fruit-tree nursery, and a miniature farmers' club which met on Sundays after Mass with the schoolmasters of the villages forming the ban in attendance. Experiments would be described and the discussions written up in a register provided by Oberlin.⁸¹ Something similar seems to have taken place in the Franche-Comté where the parish priest of Besain (Jura) organized meetings after Vespers to discuss topics such as marling. The difficulties encountered by would-be knowledge diffusers are hinted at in his wry remark of 1785: 'my peasants don't want progress because if it increases the value of their fields they are fearful that their taxes will be raised'.⁸²

Whilst sometimes noting that big farms were not automatically the best cultivated (see pp. 142–3), contemporaries generally took the view that large, well-capitalized landowners were the principal drivers of agricultural improvement. One of the contributors to Young's *Annals* readily acknowledged that the owner-exploiter yeomanry, in common with the lesser gentry, might also be progressive in outlook, but he attributed this 'either to personal character or to a spirit for agriculture in the neighbourhood',⁸³ rather than to any intrinsic qualities or command of resources. In his ideal scenario owners would invest capital, clear, drain, and fence the land before handing it over to the tenant farmer who would then make it fruitful. Historians tended to share this view until a generation ago when John Beckett⁸⁴ questioned whether the landlord and the 'home' farm really could be considered primary agents of Agricultural Enlightenment. He drew attention instead to the role played by smaller landowners, tenant farmers, and estate stewards. Professionalization would turn this latter group into 'land agents' in early nineteenth-century England, whereas in Scotland they were more commonly

⁷⁹ Elena Serrano, 'Making Oeconomic People: The Spanish Magazine of Agriculture and Arts for Parish Rectors (1797–1808)', *History and Technology*, 30:3 (2014), 1–30.

⁸⁰ Serrano, 'Making Oeconomic People', 16–17.

⁸¹ Loïc Chalmel, *Oberlin le pasteur des Lumières* (Strasbourg, 2006).

⁸² Michel Vernus, 'La Diffusion du progrès agricole en Franche-Comté de 1760 à 1889', in M. Boulet (ed.), *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945* (Dijon, 2000), p. 275.

⁸³ *Annals of Agriculture*, 26 (1796), 527.

⁸⁴ John V. Beckett, *The Aristocracy in England, 1660–1914* (Oxford, 1986), pp. 7, 136–7, 162.

known as ‘factors’ or ‘chamberlains’. Whilst this debate makes sense in the context of England and Scotland it does not map on to the situation across the Channel and across the North Sea very well. On the Continent big landowners who routinely resided on their estates were conspicuous by their absence from the countryside, and tenant farmers were generally speaking both under-educated and under-capitalized. Only the role of the estate steward offers a point for comparison.

In any case there has been something of a reaction against attempts to de-pedestal the big landowner. Scotland provides plentiful evidence of landowner activism, particularly in the 1760s and 1770s during the first phase of Agricultural Enlightenment as Tom Devine has pointed out.⁸⁵ After all, a small group of powerful magnates owned nearly all the land. In some cases, moreover, it is possible to speculate plausibly as to the intellectual influences in play. The third Duke of Buccleuch embarked upon a programme of agrarian restructuring in 1767 after spending nearly three years in the company of Adam Smith, his tutor and travelling companion on the Grand Tour.⁸⁶ In England it was the fifth Duke of Bedford who provided the impetus for improvements on his estates rather than his steward, and the same appears to have been the case on the vast Holkham estate of Thomas Coke, first Earl of Leicester. In 1792 he informed Arthur Young, ‘you could not please me more than by recommending intelligent men to come and see my farm. It is from them I gain the little knowledge I have, and derive the satisfaction of communicating improvements amongst my tenantry’.⁸⁷ Even in France where historiography lays greater stress on anonymous, piecemeal agrarian change, the role of the big landowner in the modernization process is being reassessed.⁸⁸

The agency of landlords and seigniorial overlords tends to be well recorded and impossible to mistake. Problems only arise when trying to assess motivations and impacts. In France the ‘capitalist’ seigniors whom researchers have uncovered in Burgundy and other provinces were a phenomenon of the 1760s and early 1770s.⁸⁹ Often accused of ‘feudal reaction’, that is to say the abusive exploitation of their lordly rights to collect harvest dues and enforce monopolies, they set out to emulate the physiocrats in hopes of cashing in on high grain prices via the mechanism of surplus extraction. Economic considerations were never far from the surface notwithstanding a zeal for improvement, coupled in some instances to a humani-

⁸⁵ Tom M. Devine, *The Transformation of Rural Scotland: Social Change and the Agrarian Economy, 1660–1815* (Edinburgh, 1994), p. 60.

⁸⁶ Bonnyman, ‘Agricultural Improvement in the Scottish Enlightenment’, pp. 13, 61–80.

⁸⁷ Horn, ‘The Contribution of the Propagandist to Eighteenth-Century Agricultural Improvement’, 316.

⁸⁸ See Nadine Vivier (ed.), *Elites et progrès agricoles, XVI^e–XX^e siècle* (Rennes, 2009), introduction; Caroline Le Mao and Corinne Marache (eds), *Les Elites et la terre du XVI^e siècle aux années 1930* (Paris, 2010), conclusion.

⁸⁹ Pierre de Saint-Jacob, *Les Paysans de la Bourgogne du Nord au dernier siècle de l’Ancien Régime* (Dijon, 1960), pp. 365, 413, 425; also Stéphanie Lachaud, ‘Les Conflits liés aux droits féodaux et seigneuriaux en Sauternais aux XVII^e et XVIII^e siècles’, in Le Mao and Marache (eds), *Les Elites et la terre*, p. 85. For the equivalent phenomenon in Saxony, see Michael Kopsidis and Ulrich Pfister, ‘Agricultural Development during Early Industrialization in a Low-Wage Economy: Saxony, c.1790–1830’, *EHES Working Papers in Economic History*, 39 (June 2013), 11.

tarian desire to abolish servility. In Holstein Count Hans Rantzau-Ascheberg set the pace among landlords. From 1739 he started to introduce the regional version of enclosure and convertible husbandry (*Verkoppelung*) to his estates, with the result that by 1761 the manor had been transformed into twenty compact peasant farms paying rent rather than performing labour service. In 1768 we find him engaged in an exchange with luminaries of Berne's *Oekonomische Gesellschaft* on the subject of artificial grasses and Jethro Tull's drilling techniques conducted through the intermediary of the Swiss savant Salomon Reverdil, one-time tutor to the Crown Prince of Denmark.⁹⁰

Across the Sound in the province of Scania (Sweden) Baron Rutger Macklean would also demonstrate what could be achieved by applying to his own manor the precepts of the German-, English-, French-, and Danish-language agricultural literature that he had sedulously accumulated in the library of his chateau at Svaneholm.⁹¹ In 1783 he started to reorganize the run-down estate, obliterating villages and converting peasant holdings into compact freehold units of roughly equal size. The home farm was managed using labour hired on a day-to-day basis. Many similar initiatives are reported from all over Europe: the difficulty, as already mentioned, lies in determining their significance. Lorraine had been a test-bed for agricultural reformers ever since the death of King Stanisław in 1766 when the duchy finally reverted to France. The farm of Roville near Nancy emerged in the early nineteenth century as a beacon of agronomic best practice. Its new proprietor, Antoine Bertier, made the most of a strip consolidation operation carried out before the Revolution (see pp. 207–8) and he used his enclosed fields to trial the cultivation of different fodder crops.⁹² This was the 200-hectare farm which C.-J.-A. Mathieu de Dombasle would take over in 1822 and equip with a teaching institute and an agricultural implement workshop (see p. 91).

Most of these undertakings occurred in northern Europe where commercial opportunities were greater and the *rentier* mentality less pronounced. Yet it is possible to find instances of enlightened landowners striving to set an example in regions of sharecropping and peasant micro-culture as well. Corinne Marache draws attention to the case of Marshal Thomas-Robert Bugeaud, the Napoleonic general who was forced by circumstances in 1815 to retire to his estates situated in one of the most benighted and backward corners of the Dordogne. He started by modernizing the *réserve* (home farm), clearing the land of heath, planting vines, introducing fodder crops, altering the rotations, experimenting with mulberry plantations, and so forth, before tackling the time-bound practices of his share-

⁹⁰ Prange, *Die Anfänge der grossen Agrarreformen in Schleswig-Holstein*, pp. 673–6, also <http://digi-biblio.unibe.ch/digibern/> (accessed 27 November 2014).

⁹¹ See Tomas Germundsson, 'Mackleans bokhylla', in Kerstin Cederlund, Tora Friberg, and Maria Wikhall (eds), *Geografi i Lund: essäer tillägnade Gunnar Törnqvist* (Lund, 1999), pp. 56–63. On the evidence of the sale catalogue drawn up following the death of Macklean in 1816 about a third of his library holding was devoted to works of agriculture. I am indebted to Dr Henrik Svensson for this information.

⁹² *Bulletin de la Société d'encouragement pour l'industrie nationale*, 3e année (1804), 163, 269–77; also Peter M. Jones, *Liberty and Locality in Revolutionary France: Six Villages Compared, 1760–1820* (Cambridge, 2003), pp. 244–5.

cropper households. Eight in number, they were required to sign prescriptive leases to ensure that the work of improvement would continue and not be jettisoned when the holdings changed hands. In 1820, he offered to set up a demonstration farm to showcase his successes, but as a Bonapartist and a *demi-solde* he was treated with suspicion by the Bourbon Restoration prefect of the Dordogne. Instead he established, in 1824, the first *comice* or agricultural show in the Périgord. None of this came easily and without resistance. As he wrote to an acquaintance in 1826, 'how difficult it is my friend to change the agriculture of a district. A single man would be better able to train twenty regiments than he could ensure that a whole community adopted two new principles of agriculture'.⁹³

In Scotland and England it was generally assumed that agronomic literature was accessible to the more substantial tenant farmers by the end of the century. Indeed Sinclair anticipated that 'intelligent farmers'⁹⁴ would take on the work of compiling the *General Views of Agriculture* in the 1790s. But whether they actually read the literature and whether it made a difference to their cultivation practices is another matter. On taking up the tenancy of Mossgiel farm in partnership with his brother Gilbert, Robert Burns wrote the following in a letter to the Scottish physician and writer John Moore: 'I read farming books; I calculated crops; I attended markets; and in short, in spite of "The devil, the world and the flesh," I believe I would have been a wise man; but for the first year from unfortunately buying bad seed, the second from a late harvest, we lost half of both our crops'.⁹⁵ Victor Yvart, another unusually well-educated and experienced tenant farmer who occupied a 100-hectare exploitation at Maisons-Alfort just outside Paris, rather doubted whether the English tenantry were as capable as their reputation proclaimed. He spent four years in England in the early 1780s visiting farms and other sites of interest and, on the strength of this experience, was sent over to England again during the Peace of Amiens. His report on the rural economy of France's geo-political rival emphasized that whilst standards of cultivation on the great landlord estates often merited unstinted praise, the great majority of ordinary farmers practised an unintelligent agriculture based largely on routine.⁹⁶

The position of land steward as an instigator of change should not be underestimated, even if this increasingly specialized and well-paid professional occupation did not leave much of a mark in continental Europe. Insofar as these individuals can be identified, the sources generally agree that they played 'a vital role in the

⁹³ Corinne Marache, 'Bugeaud: un stratège aux champs', in Le Mao and Marache (eds), *Les Elites et la terre*, p. 205.

⁹⁴ Rosalind Mitchison, 'The Old Board of Agriculture (1793–1822)', *English Historical Review*, 74:290 (1959), 50–1.

⁹⁵ Leask, *Robert Burns and Pastoral*, p. 31.

⁹⁶ 'si quelques lords et autres riches propriétaires, livrés par spéculation et par goût d'étude et à la pratique de cet art nourricier, ont introduit sur leurs vastes domaines une culture digne d'éloge et d'exemple, il s'en faut beaucoup que la masse des cultivateurs se distingue par une culture raisonnée; ils ont encore leurs routiniers, leurs charlatans, et leurs ignorans comme par-tout ailleurs', *Mémoires de la Société d'agriculture de la Seine*, 8 (1805), 239.

spread of agricultural improvement and efficiency'.⁹⁷ The estate agriculture of England and Scotland usually required the employment of managers to oversee tenants, re-let farms and authorize infrastructure investments on behalf of landlords. The cultural practice of agronomic travel brought their existence to the notice of elites from overseas and, by the end of the century, it is possible to detect the presence of surveyors and land stewards in the flow of skilled farm professionals heading across the Channel or the North Sea in order to take up positions of employment on estates in France, Prussia, Scandinavia, and particularly in Russia (see pp. 111–13). The activities of John Burrell, factor to the Duke of Hamilton and William Keir who managed the Scottish properties of the Duke of Buccleuch have been examined in detail, and it is apparent that their frame of reference was very much a reflection of the intellectual currents of the age which defined the type of improvement to be attempted and condemned out of hand the older land-use practices.⁹⁸

James Loch, the controversial estate manager employed by the Marquess of Stafford who was also the first Duke of Sutherland, studied law at Edinburgh and was tutored in political economy by the moral philosopher Dugald Stewart. He introduced many innovations to the marquess's Shropshire and south Staffordshire estates, among which the cropping book to record the sowings in each field on a year-by-year basis. Acting for a landlord employer who was willing to make extensive capital investments in agricultural improvement, Loch felt entitled to adopt an interventionist approach in his dealings with tenants, advising them on how to plough (two horses abreast) and what to read (Sinclair's writings on agriculture in Scotland). Information flow, he readily acknowledged, should be a multivalent process. He nurtured a wide circle of contacts which included the Whig radical Henry Brougham, the engineer John Rennie and his farmer brother George, and the agricultural toolmaker Samuel Morton of Leith Walk, Edinburgh. He would also serve as a committee member of the Society for the Dissemination of Useful Knowledge.⁹⁹

Loch would take up his pen to defend his role in the Sutherland Highland clearances and, the existence of unique estate archives apart, it is generally speaking only when stewards published works of instruction, or justification, that we can truly take the measure of their activities and successes, and failures. One such was Torkel Baden, overseer of the Bernstorffs at Gentofte. Count J. H. E. Bernstorff was the statesman who kept Denmark out of the Seven Years' War and in 1764 he launched a pioneer programme of enclosure on his estate near Copenhagen, the task of implementation being left to Baden. The steward was rewarded for his efforts with a grant of land at Ryegaard which became a showcase farm in its turn.

⁹⁷ John V. Beckett, 'Estate Management in Eighteenth-Century England: the Lowther–Spedding Relationship in Cumberland', in John Charters and David Hey (eds), *English Rural Society, 1500–1800: Essays in Honour of Joan Thirsk* (Cambridge, 1990), p. 55.

⁹⁸ Devine, *The Transformation of Rural Scotland*, pp. 65, 79, 93–4; Brian D. Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment: The Third Duke of Buccleuch, William Keir and the Buccleuch Estates, 1751–1812' (PhD dissertation, Edinburgh University, 2005), chapters 4–7.

⁹⁹ On James Loch, see Bruton, 'The Shropshire Enlightenment', pp. 199–211.

The Royal Danish Agricultural Society organized the first ploughing contest there in 1770. In 1774 Baden wrote up his experiences in a veritable manual for landowners who might be contemplating similar reforms.¹⁰⁰ Men like Baden or for that matter Keir or Loch were facilitators to be sure, but they were also instruments. Noble landlords did not inhabit their castles and chateaux all the year round and they tended to rely on agents on the ground to convert a commitment to the ideology of Agricultural Enlightenment into effective and profitable land management policies.

Still, the point remains that we may only be describing an Agricultural Enlightenment for the few. New knowledge was circulated, but did it circulate only among the converted? Did the converted consume one another's writings chiefly as a form of intellectual stimulus; in other words as an exercise paying dividends in terms of status and politeness, but with little purchase on the real economy? Arthur Young, to his credit, acknowledged the shortcomings of much of the agricultural literature adumbrated in the second half of the eighteenth century. This was why he insisted that value in agriculture resided principally in *useful* types of knowledge acquired methodically, through experience. He railed repeatedly against authors who claimed to be transmitting the results of experiments whilst neglecting to mention soil conditions or seasonal factors. The 'encyclopaedic' approach may have launched Agricultural Enlightenment, but it was not necessarily well designed to usher knowledge about farming into the safe harbour of improved practice.

¹⁰⁰ Torkel Baden, *Beskrivelse over den paa Godset Bernstorff i Gjentofte Sogn under Kiøbenhavn's Amt...* / *Description of the Estate of Bernstorff in Gjentofte Parish in Copenhagen County* (Copenhagen, 1774), see also Carl Rise Hansen and Axel Steenberg, *Jordfordeling og Udskiftning: Undersøgelser i tre Sjællandske Landsbyer* (Copenhagen, 1951), p. 480.

4

Diffusion in Practice Emulation and Innovation

'Farming is the most difficult of all the arts, and nothing has retarded its advances so much as one farmer not knowing what another is doing at a distance from him'.¹ The remark comes from one of Arthur Young's Edinburgh correspondents and it alerts us both to the overweening confidence of the Scottish improvers in the capacity of knowledge to create a level playing field and the perplexing conundrum of innovation as a practice implemented on the ground. Fifty years after the remark was uttered the agricultural journalist James Caird toured rural England and was surprised to discover farmers who were content to use old-fashioned techniques whilst their near neighbours had adopted the most up-to-date tools, machines, and field drainage methods.²

If Agricultural Enlightenment cannot be considered the work of a select band of far-sighted individuals, it must have happened by means of a largely anonymous process of 'contagion' agrarian historians have reasoned.³ However, if this was the case the process plainly did not occur in a straightforward and predictable fashion. A glance at the history of structural change as it related to Europe's agriculture quickly establishes that innovation and diffusion were discrete phenomena. Farmers did not switch to new crops, new rotations, or new harvesting technologies the moment they encountered someone already using them. The 'social learning'⁴ mechanism depended on time, place, and opportunity to be sure, but it also depended on a number of contextual factors which will be explored in this chapter.

Innovation can be approached at different levels. The historiography of agricultural revolution is studded with macro-inventions (Tull's seed drill, the Dombasle plough, glazed pipe-drains, etc.) and super-technologies (the floating of meadows, nitrogen-fixing forage crops, the Norfolk Four-Course Rotation, etc.) which single-handedly accelerated the pace of change, or so it is claimed. The phenomenal

¹ *Annals of Agriculture*, 26 (1796), 523.

² *English Agriculture 1850–51. By James Caird Esq.*, 2nd edn. (London, 1852), pp. 498–9, letter liv, 'The Farmer'.

³ Eric Kerridge seems to have been the first to present the diffusion of the 'new husbandry' in England in this fashion, see *The Agricultural Revolution* (London, 1967), p. 326 and *The Farmers of Old England* (London, 1973), pp. 130–2; also Frank Emery, 'The Mechanics of Innovation: Clover Cultivation in Wales before 1720', *Journal of Historical Geography*, 2:1 (1976), 38, 43.

⁴ Glen Ellison and Drew Fudenberg, 'Rules of Thumb for Social Learning', *Journal of Political Economy*, 101:4 (1993), 612–43.

ability of clover to boost the nutrient content of the soil when grown as a field crop has been equated with the role performed by steam power in propelling the Industrial Revolution.⁵ In the early modern period truly mould-breaking innovations were rare, however, and the arguments made for them usually turn out to be rather hollow. Innovation as a local, low-level phenomenon was almost certainly more important in triggering change. However it was largely unreported and is therefore difficult to isolate and attribute securely.

Diffusion came later, sometimes much later. In fact, it would not be unreasonable to suggest that the period of Agricultural Enlightenment was above all one characterized by the widespread diffusion and take-up of new farming techniques and technologies. Innovations conceived and trialled since the middle of the seventeenth century were brought to fruition and embedded in the rural economy whilst momentum began to build for a further spurt of innovation rooted in the application of chemistry and biology to cereal and animal husbandry. These follow-on developments would only start to make an impact in the 1840s, however. Innovation and diffusion can be theorized in various ways. Rural sociologists and development economists often distinguish between pioneers (genuine inventors and innovators), early adopters, late adopters, and laggards or non-adopters. When presented in these terms the diffusion process can be said to have reached a critical way-station in the 1850s when institutionalized knowledge and practice enshrined in agricultural colleges and research stations started to take over the running.

Whether this dissected approach to the phenomenon of diffusion offers much to the historian is less certain, though. The categories tend to blur together in the face of the impossibility of running a trial of the decision-making process among eighteenth- or early nineteenth-century cultivators. Innovators and early adopters cannot be separated by researchers when the identity and status of the person introducing a new technique remains unknown. As for the subsequent sequencing, it becomes a matter of pure conjecture. The historian may note, for instance, that semi-permanent fodder grasses (sainfoin, lucerne) were extensively planted on the territory of the village of Marines (Val d'Oise) during the second half of the eighteenth century in contrast to the village of Milly-la-Forêt (Essonnes) where the same development only occurred in the second quarter of the nineteenth century. But how the decision to alter the traditional rotation of crops and dispense with the fallow was reached in Marines compared with Milly-la-Forêt is nowhere recorded.⁶

According to a plausible scenario the rate and direction of diffusion can be linked to the spread of information (sometimes described as 'the epidemic diffusion model').⁷ However, this approach implies that all farmers are basically alike in their capacity to absorb and their willingness to act on information received. It is also rather narrowly focused inasmuch as information availability constitutes the only significant variable and one which overrides any further evaluation of benefits

⁵ See Bieleman, *Five Centuries of Farming: A Short History of Dutch Agriculture*, p. 25.

⁶ Laurent Herment, *Les Fruits du partage: petits paysans du Bassin Parisien au XIX^e siècle* (Rennes, 2012), p. 206.

⁷ Paul Diederer, Hans van Meijl, and Arjan Wolters, 'Innovation Adoption in Agriculture: Innovators, Early Adopters and Laggards', *Cahiers d'économie et sociologie rurales*, 67 (2003), 30.

as against costs. As we shall see, market 'pull' in the vicinity of Europe's major cities undoubtedly played a part in persuading some farmers to alter their practices and adopt productivity-enhancing innovations. In any case diffusion only made sense in a context of Agricultural Enlightenment if it resulted in the adoption of new technologies and practices at the aggregate level. Documenting the successful transmission of an innovation to an individual farm is a relatively straightforward matter, but we need to track, if possible, the spread of a new technology throughout a district or region.⁸ Or, at the very least, to find evidence which would allow the diffusion—adoption inference to be drawn.

Where the information comes from is also likely to have a bearing on the outcome, of course. By and large it appears that eighteenth-century farmers, if not landlords and their agents, were rather resistant to book knowledge. In chapter three we allowed for the possibility that learning by doing and by oral exchange of localized information played the preponderant role. Yet modern studies have found that farmers who prize external sources of information above all else are more likely to be early adopters of innovations than those who prefer to rely on internally generated bodies of wisdom.⁹ The role of cooperation and competition ought to be weighed in the balance, too. A cooperative approach to the task of agricultural improvement appears to facilitate the adoption of innovations developed elsewhere. This begs a question relating to the institutional environment. A number of investigators of Europe's agrarian past take the view that political and economic structures have an effect, albeit indirect, on the propensity to innovate. Jan de Vries,¹⁰ for example, points to the benign political climate in Great Britain following the constitutional revolution of 1688, whilst E. L. Jones¹¹ emphasizes the importance of a secure arena for decisions about capital investment: 'without a receptive economy the intellectual currents of the 18th century may still have inspired inventors but the social utility of their work would have been harder to realise'.

This idea is not new. The Pictet brothers observed in 1799 that farmers will only respond to tangible evidence of agricultural improvement in contexts where they enjoyed freedom and had the certainty that they would harvest the fruits of their labours.¹² But whether a cradle of supportive institutions served to stimulate innovation and diffusion at the micro-level is another matter. Agricultural societies sprang up all over Europe in the second half of the eighteenth century as we have noted, and they put in place systems to encourage and reward best practice in husbandry. However, direct testimony to the fact that such incentives actually made a difference to the pace and direction of agricultural development is sparse. Perhaps competition, which Enlightenment authors sometimes repackaged as 'emulation' provided more of a spur. Yet it is far from obvious that competition in

⁸ Gershon Feder, Richard E. Just, and David Zilberman, 'Adoption of Agricultural Innovations in Developing Countries: A Survey', *Economic Development and Cultural Change*, 33:2 (1985), 256–7.

⁹ Diederik van Meijil, and Wolters, 'Innovation Adoption in Agriculture', 42.

¹⁰ Peer H. H. Vries 'Are Coal and Colonies Really Crucial? Kenneth Pomeranz and the Great Divergence', *Journal of World History*, 12:2 (2001), 418.

¹¹ Jones, *Locating the Industrial Revolution: Inducement and Response*, p. 3.

¹² *Bibliothèque britannique*, 4 (an VII/1799), 11.

a transparent marketplace would necessarily incite innovation. In such conditions profit is likely to be eroded before the inventor of a new technology has the chance to recover his outlay costs. Perhaps this is the reason why innovators and inventors often preferred to sell their ideas to entrepreneurs, or else to solicit from governments subsidies or market protection for their products.

The role of demand factors in the twin processes of innovation and diffusion should not be overlooked. While the act of innovation or invention seems to have been tied only very loosely to economic conditions, it is reasonable to assume that incremental improvements to new technologies were undertaken with an eye to financial reward; that is to say once a purpose and a potential market for an innovation had been established. We know, for instance, that little agricultural experimentation took place in Denmark and Scotland during the long period of stagnant or declining grain prices in the first half of the eighteenth century.¹³ In conditions of plentiful labour supply, moreover, time-consuming farm activities such as the destruction of weeds scarcely provided an incentive to design mechanical drills and revolving harrows, although the lack of an obvious labour-saving application did not deter inventors and model-farm innovators of course. Knowledge-driven innovation, we must allow, was often an autonomous activity and, as such, one of the defining features of Agricultural Enlightenment.

EMULATION

In the historiography of Europe's economic development during the eighteenth and early nineteenth centuries the term 'emulation' appears chiefly as a synonym for imitation. Thus David Landes's¹⁴ classic account of the rise of the West contains a chapter entitled 'Continental Emulation' which refers to the process by which the continental European States overcame their technological 'backwardness' and bridged the gap by copying the example of Great Britain—the first industrial nation. In choosing the more colourful and perhaps more questionable phrase 'peaceful conquest', Sidney Pollard¹⁵ signalled that he, too, shared the conviction that Europe's industrialization was, in its first phase, essentially imitative. But was the Continent really backward, or just different? Few historians today would assert with this degree of confidence the paradigm status of Britain—as though the flows of innovation and diffusion were of necessity in one direction only. A more persuasive scenario would depict Britain as a special case within a broader European paradigm. Fortunately this is a debate that we need not enter. For present purposes it is sufficient to establish that historians employ the term

¹³ Karen J. Friedmann, 'Fencing, Herding, and Tethering in Denmark, from Open-Field Agriculture to Enclosure', *Agricultural History*, 58:4 (1984), 595; Devine, *The Transformation of Rural Scotland*, pp. 29–34, 42; Smout, 'A New Look at the Scottish Improvers', 133–4.

¹⁴ David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge, 1969, 2003).

¹⁵ Pollard, *Peaceful Conquest*.

emulation in a rather prosaic fashion. In the eighteenth century emulation presupposed much more than mere imitation.

John Adams, the second President of the United States of America, defined emulation as 'imitation and something more—a desire not only to equal or resemble but to excel' and he prophesied that 'emulation next to self-preservation will forever be the great spring of human action'.¹⁶ In Classical rhetoric emulation was considered to be the positive face of envy and although the two emotions were closely twinned, indeed intertwined by the eighteenth century, emulation was definitely an aspirational force which, once released, would drive men towards improvement through the mechanism of beneficent and mutually rewarding competition.¹⁷ As the century advanced, this ethic of pursuit of excellence via competition acquired dutiful and patriotic connotations as well. It comes as no surprise, therefore, to find the philosophy of emulation explicitly enshrined in many of the regulations of the agricultural and economic societies analysed in chapter three. At Kaiserslautern, for example, the Physical-Economic Society consciously used its model farm as a means of 'enticing emulation', a strategy which it considered 'more effective than the strongest rhetoric'.¹⁸ So, imitation to be sure but also improvement upon what others had achieved without any of the harmful by-products associated with open-market competition. When recommending new letting arrangements for mills on the Duke of Buccleuch's estates factor William Keir anticipated that 'an emulation would naturally arise among the millers to be obliging & serviceable in order to lure people to come to their mills'.¹⁹

Emulation was one mechanism among several for the spreading and the embedding of useful knowledge, then. In 1763 a member of the Limoges Society of Agriculture suggested that the most effective means of persuading the country dweller to adopt enlightened agricultural practices would be to 'pique his emulation with the bait of a prize'.²⁰ Observers were all too aware of practices in England and they wondered aloud whether emulation might be the ingredient, the vital force, which brought about improvement in the arts and crafts. 'Any moderately affluent Englishman', Count Sievers informed Empress Catherine II in his report recommending the creation of an independent economic society in Russia, 'feels flattered to see his name printed in the list of supporters and encouragers of the Arts, the Sciences and Agriculture'.²¹ He knew what he was talking about having been on the staff of the Russian Embassy in London at the time of the creation of the Society of Arts as we have seen. Maximilien de Lazowski whose direct experience of Britain's booming agricultural and manufacturing economy was gained a generation or so later also spoke with authority. In the memorandum which he drew up in 1787 as part of an attempt to influence the policy debate among French

¹⁶ Cited in Brooke Hindle, *Emulation and Invention* (New York, 1981), p. 16.

¹⁷ See the discussion in Hont, *Jealousy of Trade*, pp. 110–13.

¹⁸ Lowood, 'Patriotism, Profit and the Promotion of Science in the German Enlightenment', p. 147.

¹⁹ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', p. 127.

²⁰ John Shovlin, 'Emulation in Eighteenth-Century French Economic Thought', *Eighteenth-Century Studies*, 36:2 (2003), 226.

²¹ Prescott, 'The Russian Free Economic Society', 506.

ministers he pointed out that the competitive zeal of improving farmers in England was often stimulated by the award of a silver cup on which the winner's name would be recorded.²²

In a deliberate re-working of the Classical origins of the emulation impulse the Marquis de Turbilly sought to generalize the improvements he had made to his overgrown and semi-derelict estate in Anjou with the award of a large medal in silver (the size of a six-*livres* crown piece) to the tenant farmer who managed to produce the best field of wheat. It was to be worn for a year on a green ribbon hanging from the buttonhole. In a subsequent correspondence addressed to the Berne Economic Society, Turbilly explained how he had resisted the temptation to employ Classical imagery in favour of rustic symbols and a clear and simple inscription in French. The obverse portrayed a sheaf of corn with sickle, scythe, and flail, whilst the reverse carried the seigniorial shield encircled by the motto 'Pour exciter au travail les habitants du...'.²³ This initiative took place in 1755, or thereabouts, which probably makes it the earliest attempt in France to harness the power of emulation to the cause of agricultural improvement. Turbilly claimed that his innovative practices were eventually taken up by some of the farmers in the neighbourhood, but when Arthur Young paid a visit in 1788 he had the utmost difficulty in finding any surviving traces of the celebrated author of the treatise on land clearance.²⁴

In France landlord-inspired emulation fell out of fashion after 1789 for understandable reasons. In any case a persistent thread of doubt is detectable in the praise of emulation. Some felt that rivalry encouraged self-absorption. Whilst voices in the Gargunnoch Farmers' Club near Stirling extolled the benefits of the ploughing match as a visual demonstration of the skills intrinsic to capable farm servants, carefully matched draft animals and optimized agricultural implements, other observers expressed reservations. Such contests encouraged 'a propensity to vanity and idleness' as award-winning ploughmen became 'insolent and extravagant in their demands for wages'.²⁵ The Napoleonic regime in France rediscovered the merits of emulation as is evident in the tone of the two industrial exhibitions mounted amid great fanfare in 1801 and 1802, but it prudently re-fashioned the impulse into a form of 'concurrence bénéfique'²⁶ aiming to bring about nationwide improvement. Arthur Young, however, was never persuaded that honour-laden or, for that matter,

²² 'sur laquelle le nom du fermier est écrit avec une courte inscription, chose qui pique sa vanité et excite son émulation tout autrement qu'une somme d'argent', A. D. Oise 6j p 14 'Etat de l'agriculture en Angleterre'; for an example of such a practice (the award of a silver cup by the Dishley Agricultural Society), see Pawson, *Robert Bakewell*, p. 149.

²³ 'Je n'ai point voulu mettre sur cette médaille la déesse Cérès des anciens ni aucune figure hiéroglyphique; les paysans ignorants n'y auraient rien compris', Pierre-Constant Guillory aîné, *Notice sur le marquis de Turbilly, agronome angevin du XVIII^e siècle* (Angers, 1849), pp. 27–8; also Martin Stuber, 'Die Oekonomische Gesellschaft Bern als Kontaktzone im europäischen Austausch agrarisch-ökonomischen Wissens', *Discussions*, 7 (2012), 20–2, <http://www.perspectivia.net/content/publicationen/discussions/7-2012> (accessed 27 November 2014).

²⁴ Louis-François-Henri de Menon Turbilly, *Mémoire sur les défrichemens* (Amsterdam, 1762).

²⁵ Boud, 'Scottish Agricultural Improvement Societies', 81.

²⁶ See Igor Moullier, 'Un territoire comme les autres? Les départements belges et la politique industrielle napoléonienne, 1799–1814', in Corinne Maitte, Philippe Minard, Matthieu de Oliveira (eds), *La Gloire de l'industrie, XVI^e–XIX^e siècle. Faire l'histoire avec Gérard Gayot* (Rennes, 2012), p. 176.

pecuniary incentives offered a genuine means of spreading innovatory practices to the great mass of farmers. He expressed his scepticism repeatedly in the *Annals of Agriculture* where he railed against the Society of Arts amongst other bodies for using its financial resources to encourage 'frivolous'²⁷ plantings of land under acorns, mulberries, and the like.

Nevertheless, some successes were claimed by German economic societies and academies which invested heavily in the bounty system, whether awarding medals or cash premiums. In his analysis of 502 prize projects H. E. Lowood was able to establish that three-quarters involved awards for achievements in agriculture, household economics (*Hausväterliteratur*), or the mechanical arts.²⁸ In 1792 the Patriotic Society of Hamburg claimed the credit for successfully introducing the cultivation of the potato to its neighbourhood, and the Celle Agricultural Society which Albrecht Daniel Thaer had joined used premiums effectively to promote clover planting in Hannover during the final decade of the century. Much earlier, the Physical-Economic Society of Kaiserslautern had formulated a deft plan based on the use of premiums to direct farmers 'without their noticing' through a series of preliminary stages (improved rotations, clover cultivation, etc.) to the ultimate object and 'source of prosperity, namely, stall feeding'—in other words intensive dairy farming.²⁹ It is unclear, however, whether this plan was actually implemented. Friedrich Medicus, the south German physician-botanist whom we have encountered before, rather doubted whether incentives on their own could produce a structural transformation of agriculture in the absence of a culture of technical expertise linking farmers to officials and to merchants.³⁰

The same or very similar criticisms can be directed at the institution of the agricultural fair or show. Whatever the promoters' intentions these bodies often ended up preaching to the converted: prizes were awarded to those farmers who were already innovating and would continue to do so whether or not their efforts were show-cased. The idea of gathering local farmers together for ploughing competitions can be traced back to Scotland and specifically to Alloa around 1784, but the practice of face-to-face meetings of owners and tenant farmers to exchange civilities and information, watch demonstrations, and buy and sell stock was regarded on the Continent as a quintessentially English phenomenon. The Duc de Liancourt introduced something of the sort to his estate in 1784 and within a year or two the meetings were dignified with the title of '*comice*'.

After the Revolution the Napoleonic government became heavily involved and the gatherings, where they existed, swiftly shed their informal and episodic character. According to the Chevalier de La Taillais the ideal *comice agricole* needed to be exciting and eye-catching with no stinting on the platform, the drums, and the ribbonry.

²⁷ *Annals of Agriculture*, 17 (1792), 307–15 and *Annals of Agriculture*, 27 (1796), 206.

²⁸ Lowood, 'Patriotism, Profit and the Promotion of Science in the German Enlightenment', pp. 99–100.

²⁹ Lowood, 'Patriotism, Profit and the Promotion of Science in the German Enlightenment', p. 151.

³⁰ Lowood, 'Patriotism, Profit and the Promotion of Science in the German Enlightenment' p. 102; also Marcus Popplow, 'Knowledge Management to Exploit Agrarian Resources as Part of Late-Eighteenth-Century Cultures of Innovation: Friedrich Casimir Medicus and Franz von Paula Schrank', *Annals of Science*, 69:3 (2012), 413–33.

The banquet must be low cost and all the prize-winners should sit together.³¹ The aim was to draw in as many people from the outlying villages as possible, for the *comice* had become a vehicle for political as well as agricultural enlightenment. By 1843 there existed 664 of these bodies in France alongside 157 societies of agriculture and twenty-two model farms, some of which had workshops and schools or teaching institutions attached to them.³² *Comizi agrari* were beginning to appear in Piedmont by this date as well. The pioneer of the agricultural show in Switzerland and the German-speaking lands was Emanuel von Fellenberg. He organized agricultural 'festivals' to display the achievements of his model farm at Hofwyl in the canton of Berne. In 1808 Charles Pictet recounted one where over a thousand spectators came to watch a demonstration of the estate's high-performance machines. Yet he was rather equivocal about the exercise and would only grant Fellenberg a narrow radius of influence, observing that the Hofwyl establishment was unlikely to trigger an agricultural revolution on the Continent.³³ We know that similar jamborees occurred in pre-Famine Ireland. However, a farmer from Cork who attended one in 1844 in expectation of acquiring 'some valuable information that he could communicate on return to show farmers' was singularly unimpressed having heard 'nothing but compliments passing from my lord this to my lord that, on his kindness to the tenantry'.³⁴ The didactic purpose of the *comice* was lost amid ceremony and back-slapping.

The model or demonstration farm (*Mustergut* in German) seemed to offer an alternative means of achieving the diffusion and adoption of knowledge and 'know-how'. Several of the agricultural societies set up their own trial sites as we have noted, and in 1790 the agricultural writer William Marshall proposed the creation of a network of such farms throughout England as a means of coordinating best practice in agriculture. Similarly ambitious schemes were canvassed during the revolutionary decade in France. The model farm should not be confused with the 'home' farm: a phenomenon largely confined to the British Isles where wealthy landowners would sometimes set up planned farms in order to show off in as conspicuous a manner as possible their commitment to agricultural improvement. On the whole historians have concluded that such farms, whatever the other purposes they may have served, were not centres of innovation.³⁵

The model farm should be kept analytically distinct from the agricultural experiment station which was a development of the 1840s and 1850s as well (see p. 177). Although some model farms did become sites of ad hoc experimentation, they were not research establishments with an explicit remit to test and extend the new agricultural science.³⁶ Most were products of the late Enlightenment vogue

³¹ Yann Lagadec, 'Comice cantonale et acculturation agricole: l'exemple de l'Ille-et-Vilaine au XIX^e siècle', *Ruralia*, 9 (2001), 26.

³² Frédéric Lullin de Châteaueux, *Voyages agronomiques en France* (Paris, 1845), p. 279.

³³ *Vues relatives à l'agriculture de la Suisse et aux moyens de la perfectionner. Par Emanuel Fellenberg* [sic]. *Traduit de l'allemand par Charles Pictet* (Geneva, 1808), pp. 91 note 96.

³⁴ Theodore W. Moody and William E. Vaughan (eds), *A New History of Ireland*, vol 5: *Ireland under the Union, I, 1801–70* (Oxford, 1989), p. 129.

³⁵ Beckett, *The Aristocracy in England*, p. 137; Robert C. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge, 2009), p. 68.

³⁶ Frank W. J. McCosh, *Boussingault: Chemist and Agriculturist* (Dordrecht and Boston, 1984), p. 96.

for indiscriminate, 'encylopædic' science and its application in the form of 'rational' agriculture. In old age Baron Rougier de la Bergerie penned a scathing indictment of the model farm movement he had witnessed in his younger days. Not entirely fairly, he derided model farm practitioners as individuals who supposed that anything could be grown or raised anywhere—irrespective of natural conditions.³⁷ Arthur Young, who could also be rather indiscriminate in his advocacy of new crops such as the turnip, adopted a reserved attitude towards the model farm it is true. He considered them to be more recreational than utilitarian and therefore questioned their capacity to trigger the reflex of emulation.

The two establishments which probably *did* contribute something of enduring value—to soil science if not to plant nutrition—were Albrecht Daniel Thaer's farm at Möglin and Baron Casper von Voght's at Klein-Flottbek between Altona and Hamburg. Voght poured a substantial mercantile fortune into the purchase and development of his estate and model farm between 1785 and 1828, adding a training institution as he went along. The site rapidly became a tourist attraction for savants. In 1797 Voght informed Sir James Edward Smith, botanist and founder of the Linnean Society, that he was farming 500 acres alongside the river Elbe: 'I teach my neighbours the use of marling, of oxen, and of better implements of agriculture'.³⁸ Holstein was a region already noted for its advanced agriculture, of course. However, Voght's remarks about his neighbours were hedged around with statements couched in the conditional tense which raises questions about the extent of the impact of Flottbek in the neighbourhood.³⁹

The impact of Hofwyl, the estate purchased in 1799 by the Berne patrician Emanuel von Fellenberg, was initially rather limited as we know from Charles Pictet. In part this seems to have been because Fellenberg showed a reluctance to put his farming ideas and experiences into print. As a result he would become better known (and more influential) as an educational theorist than as an agronomist. Nevertheless, the Hofwyl operation not only survived into the 1840s, it eventually turned a profit, which is more than can be said for most model farms. Fellenberg pioneered deep ploughing and multi-course rotations having sought advice on the planting of fodder crops from the Berne Economic Society. Open pasture was quickly eradicated and all stock moved into sheds. His *extirpateurs* or weeding machines and seed drills were the marvel of the canton, although much too expensive for widespread adoption. He carried out experiments on manures and methods of storing grain, a technology which had largely been lost in Europe as well. Totally up-to-date with the latest developments in English agriculture

³⁷ 'si on veut forcer la nature du climat ou celle des localités, c'est-à-dire si on veut cultiver la vigne dans les pays de granit ... avoir des mules qui rivalisent avec celles du Bas-Poitou, des bêtes à laine qui effacent celles de la Mesta, des lins qui soutiennent la concurrence avec ceux de Valenciennes ... des vins à Roville qui fassent oublier les Vosne et le Clos-Vougeot', Rougier de La Bergerie, *Considérations générales sur l'histoire*, pp. 238–9.

³⁸ *Memoir and Correspondence of the Late Sir James Edward Smith, edited by Lady Smith*. 2 vols. (London, 1832), i, p. 73.

³⁹ *Memoir and Correspondence of the Late Sir James Edward Smith*, 'if they learn to keep half the teams they have now, and save one half of the seed they annually throw into the ground—then the same ground will nourish thrice the number now living upon it'.

(Bakewell's sheep-breeding experiments and Elkington's field-drainage technology) Fellenberg seems to have accepted that he was establishing a benchmark for other big farmers, of whom there were few in the Swiss cantons, and scarcely anyone else. Pictet hinted as much when he recorded that 'les Anglais eux-mêmes y trouveront beaucoup à apprendre'.⁴⁰

The long-established Hofwyl venture was probably in the forefront of Mathieu de Dombasle's mind when he took over Antoine Bertier's estate at Roville in Lorraine with the intention of turning it into a model farm. He was conversant with the machines used at Hofwyl having worked for some years on an improved plough design of his own (see p. 121) and, like Fellenberg, he was a firm advocate of deep ploughing. Roville therefore started off, in 1823, as a combined operation: demonstration farm, educational establishment, and agricultural tool workshop. The farm seems to have been an uphill struggle and only just broke even despite an extended twenty-year tenancy agreement. Although most of the fields were already consolidated and enclosed there were constant tensions with villagers over common rights, which suggests that local smallholders had little interest in the 'enlightened' agricultural practices of the dominant landowner. Probably the most influential novelty was the ploughing contest introduced by Mathieu de Dombasle in 1824. It ran for eight years and doubled up as an agricultural show at which stock could be bought and sold, including specimens from the estate's flock of merino sheep. Rather more successful as exercises in practical knowledge dissemination were the school and the occasional publication known as the *Annales agricoles de Roville* (1824–37) in which Mathieu de Dombasle offered the public a running account of his farming activities, his successes, and his setbacks.

The Roville institute or school trained nearly 400 young men drawn from all over Europe in estate management. Many would go on to hold senior positions in the post-1830 generation of institutions offering a more formal and structured agricultural education. Roville scarcely provided hands-on experience of husbandry, though: pupils generally spent the mornings visiting the farm and quizzing the foremen who supervised the labour teams engaged in ploughing, sowing, or harvesting; then, in the afternoons, they studied agronomic and veterinary texts, mineralogy and botany. Although personally well schooled in chemistry, Mathieu de Dombasle was rather hostile to the idea that agriculture should be redefined as a discrete practical science. The impact of the agricultural implement factory, which was by far the most profitable part of the Roville operation, will be considered in chapter five.

HUSBANDRY OLD AND NEW

The shift from an old-style agriculture to a new one via the processes of emulation and innovation is chiefly observable in retrospect. In this regard it is important to keep a sense of perspective, in other words to bear in mind the fact that the majority of landowners were in all probability not very interested in agriculture as such,

⁴⁰ *Vues relatives à l'agriculture de la Suisse*, p. 8.

or in its capacity for improvement. The 'job' of agriculture was to provide food, raw materials, and large amounts of rental income for Europe's elites. As argued in chapter two, only when the State started to take an interest in securing a greater share of agricultural surplus did this situation begin to change.

Peasant cultivators persisted in growing cereal crops on unsuitable soils not because of an obstinate adherence to 'routine' or a lack of 'enlightenment', but because the majority had little choice in the matter. In all but a few favoured corners of Europe, the carriage of grain overland was prohibitively expensive. Before the transportation revolution of the 1840s, therefore, markets tended to be short-range and bread grains (usually rye which was tolerant of acidic soils) were both planted and consumed in situ. Given that a perennial anxiety over crop failure prevailed in much of continental Europe well into the nineteenth century, most farmland was devoted to the cultivation of cereals. Livestock were kept chiefly as a source of manure and to provide traction for ploughing, carting, and so on. Any land removed from tillage in order to plant vines, say, or industrial crops, or even green forage attracted a jealous eye. The claim that higher yields could be achieved if *less* rather than *more* land was ploughed up tended to be greeted with weary scepticism as many an English observer noted. England was primarily a meat-eating rather than a bread-consuming society as continental travellers all too frequently observed. Besides, farmers in the more favoured eastern and south-eastern counties of England had discovered that it was actually possible to produce more grain on less ground if clover or turnips were inserted into the crop rotation.

Open-field farming which has been referred to as a 'socially controlled agro-system'⁴¹ predominated in most of the arable zones of Europe still at the end of the eighteenth century. Only in Flanders (French and Austrian), in parts of the Netherlands, in the bocage regions of western France, in the intensively cultivated belts of territory encircling major cities, and in certain alluvial river valleys would this generalization not apply (see p. 190–1). It is true, however, that Great Britain no longer conformed to the continental stereotype by this date, for enclosure in the seventeenth and eighteenth centuries had almost completely altered the landscape. In all probability no more than a third of the agricultural territory remained open-field in 1700 and by 1850 this fraction had dropped to under one-tenth.⁴²

Farming conducted on such a basis usually presupposed the division of the arable territory of each village, manor or parish into two, three, or perhaps four large fields on which grain crops were rotated at intervals. Rotation was necessary in order to mitigate the effects of soil exhaustion and one field would always be left fallow (cleaned of weeds but devoid of cereals) in order to recover in time for the planting of the winter grain crop. In France roughly 23.5 million hectares⁴³ of land were considered fit for cereal cultivation in the 1780s, of which about 31 per cent was subject to a three-field and 69 per cent to a two-field rotation.⁴⁴ It follows that

⁴¹ *Rural History 2013 (First Conference of the European Rural History Organisation [EURHO])*, University of Berne, 19–21 August 2013, panel 1.05 *résumé*.

⁴² Mokyr, *The Enlightened Economy*, p. 173.

⁴³ A. D. Oise 6jp 14 'Mémoire sur l'agriculture en Angleterre, folio 26'.

⁴⁴ Georges Weulersse, *La Physiocratie à l'aube de la Révolution* (Paris, 1995), p. 67.

very extensive tracts of potentially crop-bearing ground were left unplanted each year. It can also be inferred that the fallow field was the obvious site for agricultural innovation. In England by contrast fallow acreages had dwindled, on the average, to about 20 per cent of the total arable by the end of the seventeenth century, and 12 per cent by the 1830s.⁴⁵

Open-field farming was a socially controlled arrangement for two main reasons. Organizing the rotation of crops across village fields required collective decision-taking and since each unenclosed field was sub-divided into separately owned plots some mechanism had also to be put in place to ensure that all farmers carried out sowing, harvesting, gleaning, and stubble-grazing activities at the same time. The separately owned plots were in fact elongated strips of land so as to facilitate ploughing. In regions where drainage was a problem they would be raised into ridges and divided from neighbouring strips not by hedges or ditches, but by deep furrows. Very few owners possessed compact holdings of arable land; instead a 'farm' would consist of a scatter of strips located in each of the fields, an arrangement which, if nothing else, provided some compensation for soil variability and climate- or disease-induced crop failure. The village community or manor exercised control over what could be planted (generally speaking all grain crops growing in a field were alike), when sowing took place, and when the harvest could be taken since the majority of cultivated strips in a field would allow no independent access. In addition, the village asserted and policed an array of 'common' or 'collective' rights which granted to all members of the community entry to farmland for gleaning and grazing. In some localities even unenclosed natural meadowland ceased to be the private preserve of the owner once the first hay harvest had been carted away. In Lorraine where the collective rights associated with open-field farming were staunchly defended, virtually every village maintained a common flock or herd. On leaving Mars-la-Tour in the direction of Metz at four o'clock one morning Arthur Young recalled how he encountered the village herdsman sounding his horn: 'it was droll to see every door vomiting out its hogs or sheep, and some a few goats, the flock collecting as it advances'.⁴⁶

In such conditions freehold property and individualized holdings—the mantras of Agricultural Enlightenment—can only be described as fabulous misnomers. Yet as we have noted, there also existed zones where farmland was worked in relatively small but compact blocks and cropped continuously without interference from other owners or the legion of landless poor. In Flanders, for instance, open-field farming had not been practised since the late Middle Ages, nor had concomitant fallowing in order to rest the soil. 'I have to observe', reported a correspondent of the Board of Agriculture, 'that stubbles remaining through winter, are also totally banished, so much so, that if any piece of ground was seen in stubble a fortnight after the harvest, it would be supposed that the farmer was broke and run away. Every plot of arable ground grows to crops of some kind every year; as the corn is

⁴⁵ Overton, *Agricultural Revolution in England*, p. 99. For slightly different figures, see Broadberry et al., *British Economic Growth*, p. 74 table 2.10.

⁴⁶ *Arthur Young's Travels in France*, 13 July 1789.

taking off from one end of the field, the plough is working on the other'.⁴⁷ In such an environment it was hard to specify what courses of rotations were being followed, except that they were highly complex and individualized. Paolo Balsamo, professor of agriculture at the University of Palermo, likened the petty farmers of Flanders to 'gardeners' who 'without any fixed rule, sow on their land whatever they can, to get the most profit'.⁴⁸

He went on to observe, disapprovingly, that the fields were surrounded by 'contiguous hedges'⁴⁹ which cast shadows over the crops. On the evidence of the late eighteenth century, however, enclosure was not a precondition for intensive, fallow-free farming. In the vicinity of major towns and cities it was often possible to adapt the open-field environment and abolish, or largely eradicate, the need to leave ground unplanted. Eradication could be achieved either by employing urban night soil and street sweepings as manure, or, as we shall see, by inserting fertility-enhancing legumes such as clover into the cropping cycle. This happened on the open cereal plains around Paris, although the total abolition of the fallow only occurred in this region during first half of the nineteenth century. In Denmark, the night soil produced by Copenhagen (population 100,000 in 1800) was carted out to farms on a radius of ten kilometres from the capital. Something similar occurred in Midlothian which received 40,000 cartloads of Edinburgh street sweepings annually and also in Barcelona.⁵⁰ Suffolk farmers likewise received barge-loads of muck from London which helped them to dispense with the fallow and switch to a continuous four-year crop rotation.

Often enough these country–town relationships were symbiotic inasmuch as the waggons and barges used to carry produce returned bearing precious cargoes of stable manure. The phenomenon has been documented by Jean-Marc Moriceau and Gilles Postel-Vinay⁵¹ in respect of Paris—evidence in support of Robert Allen's contention that 'The city drove the countryside—not the reverse'.⁵² Market 'pull' as a force for innovation and intensification plainly operated in the vast agricultural hinterland of London as well. The argument should be used with care, though, for such relationships did not develop automatically. The small-town agronomists of Blaison near Angers, a port on the river Loire, complained that the grain boats sent downstream to Nantes returned empty.⁵³ In any case, intensification in the vicinity of major population centres was no guide to the state of agriculture in general, and scarcely allows an overview of the diffusion process in all its facets. In 1789 the agronomist Simon Clicquot de Blervache⁵⁴ issued a warning against reasoning based on the appearance of the fields on the outskirts of towns and Charles

⁴⁷ *Communications to the Board of Agriculture*, 6 (1808), 212.

⁴⁸ *Annals of Agriculture*, 14 (1790), 336.

⁴⁹ *Annals of Agriculture*, 14 (1790), 328.

⁵⁰ *Annals of Agriculture*, 8 (1787), 247.

⁵¹ Jean-Marc Moriceau and Gilles Postel-Vinay, *Ferme, entreprise, famille: grande exploitation et changements agricoles: les Chartier, XVII^e–XIX^e siècles* (Paris, 1992), pp. 204–6, 239–41.

⁵² Allen, *The British Industrial Revolution*, p. 58.

⁵³ Antoine Follain (ed.), *Une Société agronome au XVIII^e siècle, les Thesmophores de Blaison en Anjou* (Dijon, 2010), p. 127.

⁵⁴ 'Les engrais y sont si faciles, si peu couteux, le bénéfice des basses-cours, le prix des denrées si avantageux, qu'il ne faut pas en comparer le produit avec celui des terres des autres provinces', quoted in Weulersse, *La Physiocratie à l'aube de la Révolution*, p. 172.

Pictet de Rochemont would do the same when reporting on Fellenberg's successes at Hofwyl.⁵⁵

The old agricultural system based on open-fields, shared rights, and community policing was not impervious to change as researchers now recognize. In fact it is probably true to say that it was constantly evolving. In Lorraine where village territories had often become indistinct as a result of warfare and population loss in the 1620s and 1630s, a conscious effort had to be made to reconstitute the open-field environment and recalibrate the rotations. Even so, many parcels of land would have escaped and remained beyond the jurisdiction of the three-field agricultural economy. The Grand Ban de Vittel, for instance, was divided or re-divided in the early eighteenth century into three fields plus sixteen plots of land *not* subject to the standard rotation.⁵⁶ Such arrangements, however fortuitous, created scope for innovation. However, it is much easier to find the traces of open-field innovation than it is to penetrate the decision-making process that brought it about. When reconnoitring the valley of the river Marne near Epernay in 1770 Joseph Marshall noticed that 'clover here is very much sown in the common fields by consent of all the proprietors, and in a system of management which appears to be very good'.⁵⁷ Robert Allen thinks that individual farmers would have agreed among themselves to withdraw strips from the open-fields in order to create, for example, an artificial meadow. This is what happened in the parish of Spelsbury (Oxfordshire) apparently, where a number of copyholders contrived to grow sainfoin, and in due course clover and turnips, by this route.⁵⁸

No doubt the origins of *Koppelwirtschaft* in Schleswig-Holstein and Baltic Germany can be found in similar local agreements. Open-fields were subdivided using a fence or a hedge (*Koppel*) to create smaller plots that allowed experimentation with more complex rotations on the Flanders pattern, albeit still within the broad framework of a manorial economy. The scene depicted in Figure 4.1 shows just such a process.⁵⁹ In the foreground earth is being extracted to create a bank while the field is being sectioned with hedging planted on the banks. Meanwhile, in the middleground and background, boulders are being removed by blasting or else by splitting with wedges. The Latin inscription reads, 'Thus, with a thick hedge we enclose the land'. Another example would be the ingenious solution employed in Groningen (coastal Netherlands) to overcome the annual fallowing constraint of the old agricultural system. According to Jan van Zanden, Groningen cultivators devised a means 'whereby beans were sown in widely spaced rows (every fifth or sixth furrow) during the fallow year. Farmers were thus able to repeatedly work and fertilise the strips between the rows of beans during the early summer months; in August the farmers then planted coleseed on these strips. After the beans were

⁵⁵ *Vues relatives à l'agriculture de la Suisse*, p. 13.

⁵⁶ François Reitel, 'À Propos de l'openfield lorrain', *Revue géographique de l'Est*, 6 (1966), 30–1.

⁵⁷ Marshall, *Travels through France and Spain*, p. 123.

⁵⁸ Allen, *The British Industrial Revolution*, pp. 68–9.

⁵⁹ See Jörg Matthies, 'Oest, Bechstedt und Hirschfeld. Drei Schöpfer einer neuen Kulturlandschaft im 18. Jahrhundert', in Rainer Hering, *Die Ordnung der Natur: Vorträge zu historischen Gärten und Parks in Schleswig-Holstein* (Hamburg), pp. 71–94, <http://hup.sub.uni-hamburg.de> (accessed 20 March 2015).

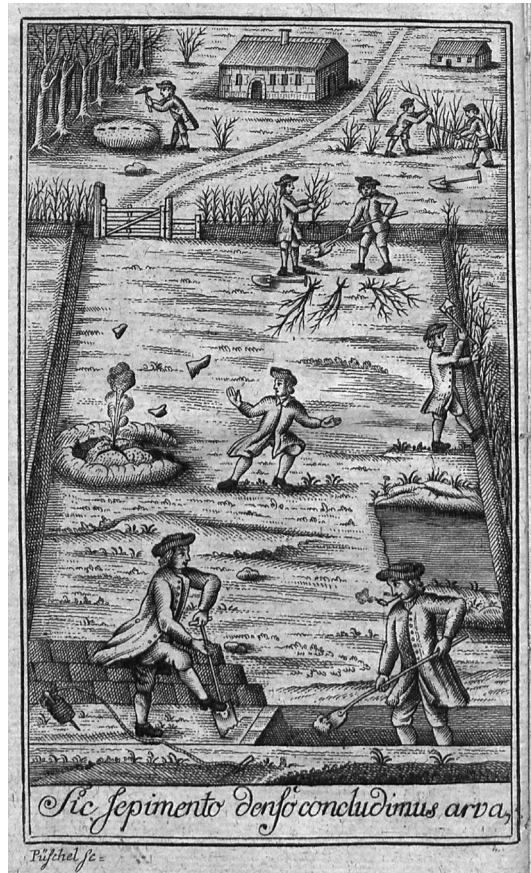


Figure 4.1. *Verkoppeling* (Enclosure with Hedges) in action

Source: N. Oest, *Oeconomisch-Practische Anweisung zur Einfriedigung der Ländereien* (Flensburg, 1767).

harvested, the area between the strips of coleseed could be plowed, grubbed, and weeded before winter and in the spring'. This strategy, he reminds us, was a conscious 'attempt to combine the traditional fallow with crop cultivation'.⁶⁰ It is a matter for regret that these anonymous farmer-experimenters cannot be identified, for otherwise we might be able to find out who the open-field innovators and early adopters really were.

Both the theorists and the agents of Agricultural Enlightenment were of one mind on the subject of fodder crops. They represented the single most important advance in agriculture as traditionally conceived and practised in the era before the introduction of artificial fertilizers. Only the arrival of the potato as a crop grown for human consumption would make a comparable impact—but later, in the early

⁶⁰ Jan Luiten van Zanden, *The Transformation of European Agriculture in the Nineteenth Century: The Case of the Netherlands* (Amsterdam, 1994), p. 72.

decades of the nineteenth century. The field planting of clover, sainfoin, and lucerne began in the 1740s and 1750s, initially, it seems, as a solution to the under-utilization of the fallow although the enduring benefits to the soil of these leguminous plants were swiftly grasped, if poorly understood. They all produced fodder which could either be used on the farm or, more likely, traded with the town. Clover was the easiest to introduce because it only stayed in the ground for a relatively short time and could be inserted into existing rotations without too much difficulty. Hence the mania for red and white clover which ebbed somewhat towards the end of the century as farmers realized that it was not a panacea after all. Over-reliance on sown clover in Denmark brought disease and diminishing returns in the 1790s with the result that the acreage allocated to the plant in the rotations practised on the islands dropped sharply.⁶¹

Sainfoin and lucerne lasted longer and their cultivation presupposed, therefore, either some adjustment to open-field rotations or else an independent supply of land that had been enclosed. That said all three plants had different soil requirements. Sainfoin could be grown successfully even where humus was lacking, but not lucerne, and neither were worth planting on granite uplands. Since soil science made little headway in the eighteenth century (see p. 163), these cultivation preconditions were often ignored by overzealous officials and cabinet agronomists who claimed that such crops could be used to eradicate the fallow everywhere and anywhere. Nevertheless, they made a perceptible difference over time. Travelling through Franche-Comté at the start of the new century, the naturalist Justin Girod-Chantrans took note of the gradual diffusion over the previous fifteen years of cultivated clover radiating outwards from the regional capital of Besançon, although he hinted that farmers planting the new 'artificial grasses' as they were known had encountered difficulties defending their crops against the upholders of common rights.⁶²

Innovative rotations could also run into landlord resistance, though, particularly on the high-yielding wheat prairies around Paris where 'institutional' pressures sometimes deterred farmers from planting the fallow. Yet even here the new century would eventually bring changes—accelerated no doubt by the loosening of constraints in the years following the Revolution. The American geologist William Maclure who travelled indefatigably around Europe described the Brie as 'the best wheat country in France' in 1813, notwithstanding the fact that a traditional three-course rotation was strictly adhered to, 'Each farm was in three lots: one in wheat, one in oats, and the other fallow'.⁶³ He was back in France in 1824 but this time noticed many agricultural improvements as he made his way from Calais to Paris, notably the fact that much of the previously fallow land had been converted into clover fields.

One of the paradoxes of the transition from old to new-style agriculture on the Continent which baffled Arthur Young in particular was the failure of enclosure or farmland consolidation to engage, automatically as it were, the reflex of innovation.

⁶¹ Kjaergaard, *The Danish Revolution*, pp. 82–6.

⁶² *Bulletin de la Société d'encouragement pour l'industrie nationale*, (1805), 126–7.

⁶³ John S. Doskey (ed.), *The European Journals of William Maclure* (Philadelphia, 1988), pp. 613, 737.

'Husbandry not much further advanced, at least in skill, than among the Hurons, which appears incredible amidst inclosures',⁶⁴ he expostulated when passing close by the Breton town of Combours in 1788. Yet despite Young's censure it seems unlikely that small farmers were intrinsically deficient in innovative capacity; they preferred instead to focus energy on their garden plots as Mauro Ambrosoli has observed. It was on such plots that the habits and the practices of growing sainfoin and lucerne were maintained in readiness for the moment of transition to open-field cultivation.⁶⁵ Whilst in Denmark the reorganization of farms at the turn of the century often did result in a flurry of innovative activity, Fridlev Skrubbeltrang⁶⁶ found no fundamental changes to the cropping cycle had occurred in Vejen even fifty years after the enclosure of the parish. Marling started on the 'home' farm around the time of the consolidation, but the newly minted peasant proprietors did not follow suit until the 1830s. In England Young was not alone in his conviction that enclosed fields promoted creativity, making it possible to achieve higher profit margins. On inspecting the countryside beyond Stratford-on-Avon, the La Rochefoucauld brothers also considered it to be 'certain that enclosed fields work better than open ones, and it is natural that the fields around the house are better farmed than those at a distance'.⁶⁷ Nevertheless, land agent Thomas Davies sounded a note of caution when he observed that enclosure only brought about improvements if farmers also were keen to innovate.⁶⁸

INNOVATION AND ADOPTION

No doubt some farmers refused to innovate as a matter of principle. When Robert Burns arrived in Ayrshire in the 1780s with an agricultural pursuit in mind, the typical Nithsdale tenant farmer rebelled at the very idea of Agricultural Enlightenment: 'his hatred of innovation', we are told, 'made him entrench himself behind a breast-work of old maxims and rustics saws, which he interpreted as oracles delivered against *improvement*'.⁶⁹ Such examples can easily be multiplied. Victor Yvart who took over a big farm at Maisons-Alfort outside Paris recalled how he had refused to accept parish-pump wisdom that the ground was fit only for rye. An eighty-four year old neighbour watched him at work preparing the five-hectare fallow field with legumes and copious quantities of dung, 'taken aback and even angry at my intention to sow it with wheat'.⁷⁰ In a journey through Silesia undertaken in 1821 the sheep farmer and agricultural writer Johann Gottfried Elsner recorded an elderly peasant telling him that 'even if there

⁶⁴ *Arthur Young's Travels in France*, 1 September 1788.

⁶⁵ Ambrosoli, *The Wild and the Sown*, pp. 202–3.

⁶⁶ Fridlev Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark* (Rome, 1953), p. 96.

⁶⁷ Scarfe, *Innocent Espionage*, p. 127.

⁶⁸ See Beckett, *The Agricultural Revolution*, p. 39.

⁶⁹ *The Works of Robert Burns; with his Life by Allan Cunningham* quoted in Leask, *Robert Burns and the Pastoral*, p. 21.

⁷⁰ *Mémoires de la Société d'agriculture de la Seine*, 8 (an XIV/1805), 238.

is one or the other among us who wants to improve his tillage, he will get no thanks for it and be laughed at by the rest'.⁷¹

Yet innovation and adoption happened notwithstanding. On the Stavenow manor in Brandenburg the workings of which William Hagen⁷² has examined, the estate steward engineered the switch to a near fallow-free convertible husbandry in the 1740s. Yet this was rather unusual, he implies, since the main sites of agrarian experimentation in Prussia tended to be Crown-owned properties. Frequent knowledge exchange between practising agriculturalists certainly counted for a good deal, particularly in Georgian England. In 1793 George Boswell, a skilled constructor of water meadows, wrote from South Dorset to fellow farmer George Culley in Northumberland to report that he had been summoned to London by Sir John Sinclair who wished to interest the Board of Agriculture in an experiment to water Hyde Park and St-James's Park. Boswell was not impressed, alluding to the fact that as a tenant farmer he could ill afford to travel at his own expense on public business. In any case, he added, 'I very much doubt the utility of these things in the hands of Lords and Dukes. Plain country farmers are not at home when they are with such sort of Folks. My hand, heart and Table such as it is are allways at the command of my Friends and nothing give me greater pleasure than to exchange mutual knowledge'.⁷³

George Boswell was well known in his neighbourhood as an 'ingenious Farmer'⁷⁴ and received visitors from far afield such as Robert Bakewell and Arthur Young who came to inspect his system for producing early grass. He had experience of managing resistance to innovation, too. In 1789 deep suspicion of grain-drilling among his agricultural labourers was overcome by allowing them to sow the oats as thickly as they pleased. Although it was rare for tenant farmers to make excursions the length and breadth of the country, skilled farm workers often travelled great distances as we shall see in chapter five. Also the practice of agricultural apprenticeships seems to have shifted knowledge and skill from farm to farm most effectively in Britain. By all accounts it was in this manner that drill husbandry, and particularly the practice of drilling turnips, was transferred from the south of England to the Scottish Borders. Boswell's correspondent, George Culley, picked up the technique from this direction in fact. He first encountered the drilling of turnips on a holding near Coldstream, apparently in 1766, and introduced it to his own farm in Glendale (Northumberland) around 1780 with the observation that he had 'learned from our neighbours on the Scotch side'.⁷⁵ A decade or so later the practice had become general throughout the Glendale neighbourhood.

⁷¹ Johann Gottfried Elsner, *Landwirtschaftliche Reise durch Schlesien* (Breslau, 1823), quoted in M. R. Finlay, 'Science, Practice and Politics: German Agricultural Experiment Stations in the Nineteenth Century' (PhD dissertation, Iowa State University, 1992), pp. 1–2.

⁷² Hagen, *Ordinary Prussians*, p. 314.

⁷³ Stuart Macdonald, 'Agricultural Improvement and the Neglected Labourer', *The Agricultural History Review*, 31 (1983), 82.

⁷⁴ Joseph Bettey, 'George Boswell of Puddletown (1735–1815): Progressive Farmer and Author', *The Agricultural History Review*, 57 (2009), 60.

⁷⁵ Stuart Macdonald, 'The Diffusion of Knowledge among Northumberland Farmers, 1780–1815', *The Agricultural History Review*, 27 (1979), 37.

The founder of the Rothamsted experiment station (see pp. 181–2), John Bennet Lawes, who by all accounts had little time for book-learning once confided that his early experiments with non-organic ‘artificial’ manures were triggered by the enquiry of a neighbour who wanted to know why ground-up bone dust made no appreciable impact on his own heavy land whereas the preparation was used to good effect by farmers cultivating lighter soils. After testing the merits of various unconventional products Lawes secured, in 1842, a patent for the manufacture of ‘superphosphate’ from treated bone residues and other substances containing phosphate of lime.⁷⁶ All of these examples invite the conclusion that the mechanics of innovation and adoption were purely empirical and unconnected, or only very loosely connected, to the written word. If diffusion took place by virtue of contagion or ‘farm-gate’ interaction, it follows in the view of many researchers that explanations of Agricultural Enlightenment need not dwell overmuch on the role of seminal individuals or the impact of agronomic literature.

Mere possession of agricultural treatises where it can be established from library catalogues or probate inventories probably does not tell us very much about diffusion and take-up, it is true. Such literature was often inherited and out of date in any case. Yet Joel Mokyr urges that we look beyond the manuals and allow for the possibility that knowledge in printed form ‘spread and filtered down through networks of personal contacts and other barely visible channels’.⁷⁷ This process is captured in the commonplace book of Julien-Gabriel Sugy, a part-time farmer and carter in the Ile-de-France. Between 1830 and 1860 he jotted down scraps of useful information that had come to his attention: a remedy for cattle disease copied directly from the *Journal d’agriculture pratique* (1839), or advice on how to persuade a horse to urinate, taken ostensibly from an edition of Liger’s *La nouvelle maison rustique*.⁷⁸ We know, too, that information could trickle down to the grass roots via informal agricultural clubs and societies. In 1775 a reading circle came into being in the small Angevin town of Blaison which relayed information back and forth between local farmers and the physiocrat-inspired *Journal économique* published in Paris.⁷⁹ In Spain, on the other hand, the picture was mixed in those parishes subscribing to the *Semanario de Agricultura*. The bishop of Barbastro in the province of Huesca reported some evidence of more progressive agricultural practices and experimentation with new crops but equally the peasants, he noted, were often bored by the communal readings from the magazine.⁸⁰

In Britain tenant farmers undoubtedly accessed agronomic knowledge directly, whether from treatises, instruction manuals, or via the organs of the agricultural press which developed swiftly from the start of the nineteenth century. The *Farmer’s Magazine* was widely read in Scotland and the Borders and an article it carried in

⁷⁶ Edward J. Russell, ‘Rothamsted and its Experiment Station’, *Agricultural History*, 164 (1942), 168.

⁷⁷ Mokyr, *The Enlightened Economy*, p. 186.

⁷⁸ Laurent Herment, ‘Julien Gabriel Sugy’s Agrarian Knowledge’, unpublished paper prepared for Rural History 2013 (first conference of the European Rural History Organisation [EURHO]), University of Berne, 19–21 August 2013), p. 15. I am grateful to Dr Herment for supplying me with a copy of this paper.

⁷⁹ Follain (ed.), *Une Société agronomique au XVIII^e siècle*.

⁸⁰ Serrano, ‘Making Oeconomic People’, 17.

1807 prompted George Culley to plant an experimental crop of yellow turnips, which failed. Thomas Coke of Holkham would purchase copies of Sinclair's *Code of Agriculture* following its publication in 1819 and instructed that they be distributed to the most enterprising farmers of Norfolk. However, he was not at all sanguine about the pace of diffusion as observed on the ground, remarking wryly that his own 'improvements travelled at the rate of a mile a year'.⁸¹ English farmers and rural traders could obtain information from itinerant lecturers, too. When the La Rochefoucauld brothers viewed Bakewell's farm at Dishley in Leicestershire, they discovered that he was preparing to attend a lecture on experimental science in nearby Loughborough.⁸² Satirists mocked this earnest and over-eager pursuit of knowledge as we can see in Figure 4.2. It shows a Kentish hop merchant misunderstanding a lecture on optics.

Innovative crops together with the more specialized branches of horticulture and arboriculture benefited most from agronomic knowledge circulation. It is probable, for instance, that the advantages of planting sainfoin for animal fodder in the Paris region were weighed initially in the savant literature since the crop first appeared in seigniorial parks. Only later on was sainfoin brought into field rotations with a noticeable improvement in cereal yields. In the more immediate hinterland of Paris



Figure 4.2. *The Kentish Hop Merchant and the Lecturer on Optics*, an engraving by Cruikshank, 1809

Source: The British Museum.

⁸¹ Quoted in Mokyr, *The Enlightened Economy*, p. 192.

⁸² Scarfe, *Innocent Espionage*, p. 33; also Pawson, *Robert Bakewell*, p. 39.

whole villages specialized in the production of fruit destined for the central markets (cherries of Montmorency, peaches of Montreuil, figs of Argenteuil, etc.) and here too we can detect the influence of book knowledge, particularly expertise in grafting techniques. The treatises of Schabol (1770) and La Bretonnerie (1810) gathered up practitioner 'know-how', supplemented it and spread it around more widely. Although this was not the only means by which the 'tacit' knowledge and skills of the fruit grower were mobilized, Florent Quellier⁸³ is in no doubt that the printed literature on horticulture played a major part in the diffusion–adoption process.

Perhaps the best documented case of innovation at work on the Continent comes from Belgium, or rather the Austrian Netherlands, and it concerns Jean-Baptiste Mondez. From the age of seventeen he began consulting books on agronomy in order to prepare himself for a career as a tenant farmer and in 1774 he took over the ninety-eight-hectare estate of the chateau of Le Baulet near Fleurus. Mondez secured the consent of the owner, the Baron Philippe de Néverlée, to the abolition of the three-field system and launched a prolonged experiment in intensive husbandry which sought to transfer and adapt the key components of Flemish-style agriculture to large-scale cereal farming. Improved tools including a Dutch plough were brought in, cisterns were constructed to capture urine from stables and cowsheds, the fields were thoroughly cleansed of weeds and the dung produced by the stock augmented with imported kelp and hearth ashes.

As a mark of confidence the Baron extended Mondez's lease to twelve years in 1780. The shift from a simple three- to a complex six-year rotation was under way in any case and it would take eight harvest cycles to completely eradicate the fallow. Although the area occupied by grain crops was progressively reduced to about 50 per cent of the total arable surface in order to accommodate coleseed, flax, and sown grasses, cereal yields actually rose. In fact, output tripled between 1774 and 1809—a result which the *Société d'agriculture du département de Jemmapes* confirmed after inspecting the farm's account books. Thanks to these records we know that the farmer applied his crop rotation (flax, wheat or rye, coleseed, wheat or rye, clover, oats) to approximately fifty-seven hectares of good land divided into nine- or ten-hectare blocks. Mondez prospered as a result and in 1798, when the property of ecclesiastical institutions was put on the market, he was able to buy a holding of his own. Yet he continued to oversee the work at Le Baulet and in 1800 his lease was renewed for another twelve years.⁸⁴

Did the apparently successful introduction of Flemish husbandry to a region of large-scale cereal farming attract many imitators? The evidence is not clear-cut. Whereas local proprietors appear to have drawn the lesson and, like Philippe de Néverlée, raised their rents, which implies an intensification of land-use, Mondez for

⁸³ Florent Quellier, *Des Fruits et des hommes: l'arboriculture en Ile-de-France vers 1600—vers 1800* (Rennes, 2003), pp. 325–7.

⁸⁴ Fulgence Delleaux, 'Diffusion et application des méthodes culturales flamandes dans les anciens Pays Bas méridionaux au XVIII^e siècle: le témoignage de Jean-Baptiste Mondez fermier en Hainaut autrichien', *Revue historique*, 653 (2010), 27–58; P. Prévot, 'Gaston de Spandl (1775–1836) : maître de fosses—régisseur financier du baron Philippe de Néverlée Baulet', pp. 7–9, <http://www.fleurusouvenirs.be> (accessed 26 February 2014).

his part was not really persuaded of the innovative capacity of his fellow tenant farmers. He seems to have viewed them as resolute sceptics and late adopters. What the example does demonstrate, however, is that savant knowledge had a role to play both directly and indirectly in the process of Agricultural Enlightenment. The current historiographical focus tends to be turned towards the nimble and creative peasant polyculturalist who worked the land with family labour, but the Mondez case reminds us of the importance of charting innovatory practices issuing from more extensive farms. According to theorists of agrarian capitalism from the time of the physiocrats of the mid eighteenth century onwards, the 'gros fermier' was essentially a manager whose function was not to follow the plough for otherwise he would lack the time to reflect and make observations. Rather it was 'to think, to read, to go to market, to meet with his neighbours, to ride through the parish and county, and neighbouring counties, to see better practices, and get information from all quarters'.⁸⁵

In so far as the fallow survived in the Hainaut of Jean-Baptiste Mondez, it was largely because of landlord pressure on tenants to adhere to the traditional three-field system. In other words leases and tenurial arrangements could weigh heavily in the process of diffusion and adoption. Leases containing improving clauses appear to have been quite uncommon on the Continent which is revealing in itself. Only in southern Sweden, it appears, are we likely to encounter something of the sort. When travelling through Scania in 1804, Ernst-Moritz Arndt inspected the farm consolidations carried out at Svaneholm. He reported that Baron Rutger Macklean had experienced difficulty finding takers for the redesigned farmsteads—in part because of the risk element inherent in new cultivation methods which included a requirement to introduce clover to the rotations.⁸⁶ In the marine-clay zone of the northern Netherlands (province of Groningen) on the other hand, landlords often allowed tenants considerable latitude to use the land as they saw fit, whether 'to plough, to make hay or to pasture'.⁸⁷ In effect, therefore, they raised no objection to the adoption of a form of convertible husbandry where conditions appeared to favour ley farming.

In France leases tended to be prescriptive in a conservative sense; that is to say they were designed chiefly to prevent tenants from exhausting the soil rather than to promote enhanced productivity.⁸⁸ Long leases (beyond nine years) were frowned upon which in itself might deter farmers from planting sainfoin or lucerne, and the cultivation of cereals on the same ground two years running ('blé sur blé') was explicitly banned.⁸⁹ In the Bordelais seigniors collected hefty dues on the grape harvest with the result that tenants were threatened with expulsion if they sought to alter land use.⁹⁰ Leases explicitly worded so as to encourage general improvement

⁸⁵ *Annals of Agriculture*, 26 (1796), 523.

⁸⁶ Ernst Moritz Arndt, *Reise durch Schweden im Jahr 1804*. 4 vols. (Berlin, 1806), iv, pp. 253–73; also Sundberg, Germundsson, and Hansen (eds), *Modernisation and Tradition*, p. 138.

⁸⁷ Bieleman, *Five Centuries of Farming. A Short History of Dutch Agriculture, 1500–2000*, p. 45.

⁸⁸ Guy Brunet, *Population et environnement. Vie et mort dans la Dombes des étangs aux XVIII^e et XIX^e siècles* (Berne, 2011), pp. 43–4.

⁸⁹ Brigitte Maillard, *Les Campagnes de Touraine au XVIII^e siècle: structures agraires et économie rurale* (Rennes, 1998), pp. 214, 251.

⁹⁰ Lachaud, 'Les Conflits liés aux droits féodaux et seigneuriaux en Sauternais aux XVII^e et XVIII^e siècles', in Le Mao and Marache (eds), *Les Elites et la terre*, p. 84.

and innovatory practices were commonest in Scotland in the 1780s and 1790s, as we shall see (chapter six). It is worth noting, however, that security of tenure and even freehold owner-occupancy were not bound to facilitate improvement. In post-famine Ireland such developments served principally to freeze the landscape over the longer term and lock in agricultural inefficiency.⁹¹

Although it is true that the farm-gate empiricism of small farmers was rarely recorded for posterity, a sense of how opportunities for change arose and how they were responded to can often be obtained indirectly. In 1783 the steward of the Duke de La Rochefoucauld's property of Liancourt observed that maize was not routinely grown at this northerly latitude. The local farmers planted just a few handfuls of the seed, here and there, 'out of curiosity'.⁹² Louis Fillon, part-time farmer and weaver, was in broad agreement. Towards the end of his life he jotted down from memory how maize first appeared in his Anjou village. Initially, no one knew how to grow it and so it was only introduced to gardens and allotments on an ad hoc basis, but as knowledge of the plant's cultivation requirements expanded—by trial and error—it was transferred to the fields and sown in earnest. What he unfortunately does not tell us is whether the experimentation took place on the larger tenanted farms belonging to the chateau, or on the smaller *bordages* (under fifteen hectares), or the *closeries* (under nine hectares).⁹³

Cultivation of the potato as a food source for humans no doubt spread in a similar fashion, but in this case there is also compelling evidence of direct intervention (officially sponsored experimentation and State encouragement) to promote its planting. During the long conflict running from 1792 to 1814 both the British and the French governments came to view the potato as an innovative substitute crop with huge nutritional potential—almost as a resource of war in fact.⁹⁴ Many years later the Swiss agronomist Frédéric Lullin de Châteaueux recounted how as a young man (and a noble) at the height of the French Revolutionary Terror he had been 'persuaded' to plant potatoes by the *représentant-en-mission* (political commissar) Antoine-Louis Albitte. By the time he ordered the lifting of the tubers, though, the price control 'Maximum' of 1793–94 had been abolished and market demand for his super-abundant crop was such that it actually covered the capital cost of the land on which the potatoes had been planted.⁹⁵ In Scotland potato cultivation appealed particularly to smaller tenant farmers who found the land improvements (enclosure, drainage, liming, etc.) required to grow other roots and cereals far too daunting. Potatoes could be grown almost anywhere—even on acid soils that would take no other crop.⁹⁶ In Ireland the potato was often grown on annually sublet conacre plots which many agricultural labourers came to rely on for their subsistence.

⁹¹ John P. Huttman, 'The Impact of Land Reform on Agricultural Production in Ireland', *Agricultural History*, 46:3 (1972), 361.

⁹² A.D. Oise 6jp 13 Barauld to 'Monsieur le Duc', 20 April 1783.

⁹³ Anne Fillon, *Louis Simon villageois de l'ancienne France* (Rennes, 1996), pp. 90, 164.

⁹⁴ For the political and scientific debates surrounding this issue in France, see Emma C. Spary, *Feeding France: New Sciences of Food, 1760–1815* (Cambridge, 2014), chapter five 'The Potato Republic'.

⁹⁵ Lullin de Châteaueux, *Voyages agronomiques en France*, pp. 205–6.

⁹⁶ Handley, *The Agricultural Revolution in Scotland*, p. 120.

Advice on how to combine the potato with established crop rotations was widely available by the century's end, even if the main phase of cultivation on the Continent was largely a phenomenon of subsequent decades. Charles Pictet de Rochemont had demonstrated how it could be done on his trial farm at Lancy outside Geneva. Unlike the switch to turnip cultivation, the potato allowed for a fairly straightforward transition. A key component of the Norfolk Four-Course Rotation, turnip fields expanded steadily in England to reach about 20 per cent of the total arable acreage by 1850.⁹⁷ On the Continent, by contrast, the root was not cultivated extensively. Only in the neighbourhood of Zurich, reported Maximilien de Lazowski, could fields of turnips be found which bore some comparison with those in England, although they were much less well hoed.⁹⁸

Arthur Young never tired of recommending the turnip as a panacea to all and sundry and never showed much willingness to concede the strength of the objections raised against its insertion into rural economies structured very differently from that of England. In 1789 he attended a meeting of the Royal Agricultural Society of Paris and was invited to suggest the topic for a prize established by the *abbé* Raynal, the celebrated author of the *Histoire philosophique des deux Indes*. His proposal that the money be spent on encouraging the planting of turnips fell on deaf ears.⁹⁹ Yet he surely knew that the three-course rotation prevailing on the common grain fields around Paris required that the winter wheat be sown before the root could be dug out of the ground. No less important—as a correspondent of the *Annals of Agriculture* whom he had first met two years earlier made plain—there was little point to growing turnips on a large scale if there were no herds of cattle to eat them.¹⁰⁰ Unlike Edinburgh or London, store cattle raised for the Paris meat markets came from far afield and they were normally fattened en route to the capital on lush natural pastures in Normandy.

Innovation and diffusion were discrete but linked phenomena as this chapter has sought to demonstrate. However, it was the latter which gave Agricultural Enlightenment its temporal resonance. The process by which agricultural practices and techniques were diffused throughout Europe was highly complex and multifaceted. Whilst the market played a certain role, so undoubtedly did less tangible forces brought into play by the sentiment of 'emulation'. Few researchers would nowadays discount the significance of 'small unsung adjustments to existing implements or methods, imitated and perhaps further modified by neighbours before being written down, perhaps by a third party'.¹⁰¹ However, a problem remains when it comes to identifying and describing these 'adjustments' and the dynamics they presupposed. The same is true when we seek to scale-up the diffusion of innovative practices from individual farms to the aggregate regional level. What appears well established, though, is that information circulated extensively—no matter the

⁹⁷ Mark Overton, 'The Determinants of Crop Yields in Early Modern England', in Campbell and Overton (eds), *Land, Labour and Livestock*, p. 321.

⁹⁸ *Annals of Agriculture*, 12 (1789), 245.

⁹⁹ *Arthur Young's Travels in France*, 12 June 1789.

¹⁰⁰ *Annals of Agriculture*, 8 (1787), 339.

¹⁰¹ Smout, 'A New Look at the Scottish Improvers', 139–40.

format in which it was packaged or whether it entered the 'food chain' of innovation and adoption originally as tacit knowledge. Some allowance must also be made for exogenous factors inasmuch as the institutions of State, not to mention church tithes, surplus extraction by seigniorial overlords, and tenurial or leasing constraints played a role in day-to-day decision-making about innovation and emulation which was by no means negligible.

5

Technology in Agriculture

The role performed by technology in the diffusion process does not take up much space in the older histories of agriculture in early modern Europe. Technology is usually equated with mechanization and most researchers are in agreement that the use of machinery on the farm started to make a significant impact only in the third quarter of the nineteenth century. This is to take a rather limited view of technological change, however, and one which would remove the subject from discussion almost entirely in a book which explores the intermediate, or Agricultural Enlightenment phase of growth. It is nonetheless true that charting improvements in hand-tools—to take a narrowly ‘artifactual’ view of technology—is no straightforward matter. If we expand the definition to embrace technologies of skill (the construction of water-meadows, for instance) the task does not become any the easier. Incremental change and the ways in which it spread from one farmer to another is hard to document in a convincing fashion as has already been observed. In this chapter we take a broad approach to technology in the farmyards, in the fields and in the pastures and set out to answer a number of key questions: how was ‘technology’ understood and articulated in the context of the late eighteenth-century epistemologies sketched out in chapter one; how was it disseminated and in what directions; was it open and accessible to all potential users; how important to the diffusion process was the entrepreneurship of the improving landlord, or the mobility of the skilled farm employee; finally what role, if any, did governments play in helping to overcome the technical barriers to growth?

A further problem arises in respect of the historiography of technology for in its current socially constructed garb it is of fairly recent origin. The discipline was long approached from the subordinate and intellectually inferior angle of ‘applied science’. In other words technology consisted simply of working out how to do things with the aid of greater or lesser amounts of understanding and physical dexterity. Unlike the history of science, it had no independent knowledge base and could not be theorized—at least not before the eclipse of trial-and-error methods in the course of the nineteenth century. This was the viewpoint popularized in the 1950s by Rupert Hall¹ and co-authors of the influential multivolume work *A History of*

¹ Charles Singer, Eric J. Holmyard, and Alfred R. Hall, *A History of Technology*. 5 vols. (London, 1954–58).

Technology and, as is now apparent, it confined the field of enquiry to practical 'nuts and bolts' issues and simplified to an excessive degree the relationship between savant knowledge and 'know-how' which, after all, is also a branch of knowing albeit one not formally structured. Far from proceeding in parallel, science and technology interacted in the eighteenth century just as they continue to do in the twenty-first and it is no easy matter to allocate causal primacy to the one or the other. Eighteenth-century cameralism, formulated as *Kameralwissenschaft*, developed an 'arts and crafts' dimension as we shall see. As for the 'techno-science' pioneered in France during the revolutionary climacteric, it set out quite explicitly to tackle some of the material shortcomings of the rural economy.

That said it can be questioned whether historians of technology have found a truly satisfactory framework for analysis which goes beyond both the 'hardware' aspects of their subject and the somewhat belated acknowledgement that skill also constitutes a form of wisdom, even if it is encoded and shared in a manner rather at odds with the subject matter of savant discourse. If technology is information tied to production, it probably is helpful to think of it as the fruit of 'the integration of knowledge, organisation and technique'.² However, the idea that the thought component of technology simply mirrors the thought component of Enlightenment science does not withstand scrutiny. As Antoine Picon points out, 'technological thought is a complex system functioning at different levels. For each actor in the process of production, it comprises a mixture of 'know-how' and interiorized rules of decision-making and action'.³ The 'know-how' in question tended to be the collective intellectual property of skilled operatives which, if it could not be neatly articulated, could certainly be demonstrated and subjected to the test of experiment. The diffusion of technology in the context of Agricultural Enlightenment relied very heavily on practical demonstration as we have already had occasion to note.

Nevertheless, as historians and social scientists redefine and enlarge the scope of the history of technology, it becomes harder to determine and police the boundaries of the discipline; in other words to identify what it does and does not include. Is the division of labour within the industrial workshop a 'technology'? Or to choose a more apposite example, the introduction of complex crop rotations in the place of traditional three-course husbandry? Rachel Laudan⁴ has drawn attention to this difficulty which grows more acute as the attention of researchers switches from objects or 'artifacts' to practices, whether the actual performance of productive work or its rhetorical construction. If technology is to be understood as a new science of 'purposive action'⁵ which embraces all and any of the means devised to achieve practical ends, the task of maintaining a clear distinction between knowing

² Kristine Bruland, 'New Technologies and the Industrial Revolution', in Natasha Coquery, Liliane Hilaire-Pérez, Line Sallmann, and Catherine Verna (eds), *Artisans, industrie: nouvelles révolutions du Moyen Âge à nos jours* (Lyon, 2004), p. 64.

³ Antoine Picon, 'Towards a History of Technological Thought', in Robert Fox (ed.), *Technological Change: Methods and Themes in the History of Technology* (Amsterdam, 1996), p. 40.

⁴ Rachel Laudan, 'Natural Alliance or Forced Marriage? Changing Relations between the Histories of Science and Technology', *Technology and Culture*, 36:2 (1995), 25–6.

⁵ Laudan, 'Natural Alliance or Forced Marriage?' p. 26; also Liliane Hilaire-Pérez, 'Technology as Public Culture in the Eighteenth Century: the Artisans' Legacy', *History of Science*, 45 (2007), 1.

and doing scarcely seems worthwhile. Perhaps, as Paul Forman⁶ has argued, the history of science can no longer be considered to have an existence outside and beyond the history of technology.

Late eighteenth-century commentators for whom 'useful knowledge' was fast becoming a category in its own right had already anticipated this argument of course. In France the Comte de Chaptal recorded his disquiet that the Revolution of 1789 had not done more to bridge the knowledge divide between savants and skilled workers. In a speech delivered in 1804 to the *Société d'encouragement pour l'industrie nationale* of which he was the patron, he blamed the *ancien régime* which had given science an elitist, not to say an aristocratic inflection. In reality, he insisted, practice and theory 'are inseparable and have never have been separated'.⁷ This was wishful thinking, however. When the American geologist and inveterate traveller William Maclure passed through the industrial city of Lyon several years later he complained that the scientific expertise of the newly-fledged French Nation had been removed from the provinces and relocated in Paris: 'There is little or no science here, though most of them [the inhabitants] are connected with manufactories. Not one cabinet and few or no amateurs. All is at Paris, where they are occupied with speculative theories, nine-tenths of which are of a nature not to admit of any useful practice'.⁸

It is significant that he should extend this observation with a comparative comment on the situation in the German-speaking lands where 'men of science and knowledge are scattered over the whole country, and mixed with the artisans who can establish useful arts on the ingenious speculations of those who work in cabinets'.⁹ The term *Technologie* was first coined in Germany by the Göttingen University professor Johann Beckmann who had been teaching the cameralist curriculum since the start of the 1770s. In common with most cameralist teaching the main aim was to describe and classify rather than to explain phenomena. Accordingly, Beckmann adopted the natural history format of Linnaeus and applied it to craft and trade knowledge and 'know-how'. In two works (*Anleitung zur Technologie* [1777] and *Entwurf der allgemeinen Technologie* [1806]) he laid out the parameters of what in his 'Guide' he called 'the science that teaches the processing of natural things or the knowledge of the crafts'.¹⁰ The second publication took the classificatory exercise a step further and distinguished between 'general' technology and 'special' technology. Whilst the latter category embraced the *modus operandi* of specific crafts and trades treated descriptively, the former was reserved for the theory and principles of productive systems, or how craft workers achieved their goals in more general terms.

In the light of the discussion in chapter one it is scarcely necessary to add that *Technologie* embraced agriculture as one of the main occupational groupings alongside manufacturing and commercial activity. Indeed, Beckmann preceded his

⁶ Paul Forman, 'The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology', *History and Technology*, 23:1/2 (2007), 1–152.

⁷ *Bulletin de la Société d'encouragement pour l'industrie nationale*, 3^e année (Paris, 1804), 4; also Jeff Horn and Margaret C. Jacob, 'Jean-Antoine Chaptal and the Cultural Roots of French Industrialization', *Technology and Culture*, 39:4 (1998), 676.

⁸ Doskey (ed.), *The European Journals of William Maclure*, p. 559.

⁹ Doskey (ed.), *The European Journals of William Maclure*, p. 559.

¹⁰ Anthonie Meijers (ed.), *Philosophy of Technology and Engineering Sciences* (Amsterdam, 2009), p. 180.



Figure 5.1. *Agriculture, Labourage*

Source: *Recueil des planches sur les sciences, les arts libéraux, et les arts mécaniques, avec leur explication*, tome 1: *Agriculture* (Paris, 1762).

attempt to elaborate a taxonomic system for technology with a work on agriculture (*Grundsätze der deutschen Landwirtschaft* [1769]). Its purpose was of a piece: to order and hopefully thereby to stabilize the increments to human knowledge at a time of accelerating change and innovation so that administrators were equipped to make well-informed policy decisions. The new *Technologie* was insinuated into French industrial thinking by way of the Revolution, although it is true that the *Encyclopédie* had provided a generous if not always up-to-date treatment of the rural arts and crafts. The tableau reproduced in Figure 5.1 is drawn from one of the *Encyclopédie*'s volumes of plates relating to 'Agriculture and the Rustic Economy'. In the foreground it juxtaposes a common plough (on the right) and Jethro Tull's prototype four-coulter plough. The savant-technologist Jean-Henri Hassenfratz used the term 'technologie' in the title of a course of lectures he delivered at the Lycée des Arts in 1793 and it seems likely that Chaptal was familiar with Beckmann's writings almost from the outset as well. The *Anleitung* had run through five editions

by 1802, including a translation into Danish in 1798. In 1802 the *Société d'encouragement* resolved to have the book translated into French, although it showed some reluctance to acknowledge the case for treating technology as a free-standing science.¹¹ The clinching argument for a translation seems to have been national advantage: the study and teaching of technology was already well established in German universities and post-revolutionary France could not afford to be left behind.

SKILLED LABOUR MOBILITY

In 1825 the English toolmaker Henry Maudslay reported that artisans were flocking to the Continent now that the British government's ban on the emigration of entrepreneurs and factory operatives had been lifted.¹² 'Technology', observes E. L. Jones, 'is geographically mobile'¹³ which is indisputable provided we bear in mind the caveat that the mere diffusion of skilled manpower, machinery, and improved manufacturing processes will not *ipso facto* ensure adoption in the host country. When passing through the town of Mâcon in the Beaujolais William Maclure paid a visit to a woollen blanket-weaving factory where he watched two men operating a loom with a clumsy shuttle: 'I enquired if they had ever seen the fly shuttle, the use of which would save one man's labor. They had, but it would not suit them: that is they would not change'.¹⁴

Most studies of labour mobility dwell on the behaviour of craft workers at the dawn of the Industrial Revolution. They leave out of account the peregrinations of the very considerable numbers of skilled workers and managers who, in various roles, spread Agricultural Enlightenment and thereby contributed to the modernization of the rural economy. Such studies are apt to envisage the process of skill diffusion as a 'transfer' from a location abundant in inventiveness, 'know-how' and manufacturing capacity to one which is deficient. Whilst this model may adequately characterize the export of English and Scottish agricultural hardware (hand-tools and machinery) to the countries of the Continent in the final decade of the eighteenth and the earliest decades of the nineteenth centuries, it runs the risk of greatly simplifying the geometry of diffusion and take-up with the implication that 'transfer' operated in one direction only. In reality the movement of technology—whatever its description—tended to be polyvalent. It is for this reason that specialists often prefer to conceive of the spread of techniques throughout Europe as a process rooted in 'circulation', an image which captures rather better

¹¹ 'la technologie, d'ailleurs, n'étant point une science proprement dite, mais l'application des sciences, en général, aux besoins de la vie, nécessite une connaissance plus qu'élémentaire de ces mêmes sciences', *Bulletin de la Société d'encouragement pour l'industrie nationale*, 1 (1802), 178.

¹² William O. Henderson, *Britain and Industrial Europe, 1750–1870: Studies in British Influence on the Industrial Revolution in Western Europe* (Liverpool, 1954), p. 122.

¹³ Jones, *Locating the Industrial Revolution*, p. 95.

¹⁴ Doskey (ed.), *The European Journals of William Maclure*, pp. 652–3.

the often indeterminate way in which opportunities to acquire useful knowledge arose and were—or were not—acted on.

Endorsing the concept of circulation, Liliane Hilaire-Pérez and Catherine Verna depict the movement of technical knowledge in the following fashion:

It was shared through multiple networks (both private and public), and it involved a great diversity of strategies and varying degrees of openness within families, partnerships and guilds. Diverse media were used: verbal or non-verbal (for example, products and artifacts conveying prescriptive knowledge such as prototypes, patterns, models, and molds), oral (speech contact), and written (including all sorts of drawings, from plates to sketches).¹⁵

This is an approach we can use in the case of agricultural technology even if the contemporary rhetoric of provenance and sometimes even the undoubted reality of ‘one-way’ transfer need also to be weighed in the balance. In 1800 Albrecht Daniel Thaer would complain that the Agricultural Society of Celle was being swamped with requests for models of the ‘English and other tools’ he had recommended, presumably as a result of the publication two years earlier of the first volume of his book championing British agricultural practices and techniques.¹⁶ However, when we deploy the various theories of technical knowledge diffusion it is important to keep in mind the rider that the transplanting of a technology (whether James Watt’s improved steam engine or James Small’s chain plough), proved most durable when a complete ‘package’¹⁷ was on offer. In other words success was often dependent not only on access to hardware or artifacts, but on entrepreneurial ambition, the availability of skilled practitioners and favourable political and economic conditions.

There is a large primary literature on skilled labour mobility albeit a rather fragmentary one. However, when it is pieced together no other source demonstrates more vividly the fact that Agricultural Enlightenment was a pan-European endeavour. The project to bring useful knowledge to bear on agriculture was multi-layered in the sense that both individual initiative and government interventionism was involved, and it formed but a part of the much larger commitment of enlightened men and women to travel with a growing emphasis on technological travel in particular, and to structured social intercourse.¹⁸ It is impossible to know how many Europeans took up the practice of investigative, fact-finding tourism once it became safe to stray cross national borders in the 1760s: some figures for English gentlemen travelling on the Continent with their families were given in chapter

¹⁵ Liliane Hilaire-Pérez and Catherine Verna, ‘Dissemination of Technical Knowledge in the Middle Ages and the Early Modern Era: New Approaches and Methodological Issues’, *Technology and Culture*, 47 (2006), 541.

¹⁶ Albrecht Daniel Thaer, *Einleitung zur Kenntniss der Englischen Landwirtschaft* [...]. 3 vols. (1798–1804), see Lowood, ‘Patriotism, Profit and the Promotion of Science in the German Enlightenment’, p. 148.

¹⁷ On this issue see Ian Inkster, *Scientific Culture and Urbanisation in Industrialising Britain* (Aldershot, 1997), p. 426.

¹⁸ Peter M. Jones, ‘“Commerce des Lumières”: The International Trade in Technology, 1763–1815’, *Quaderns d’historia de l’enginyeria*, 10 (2009), 67–82.

three but many of these would have been embarking on the Grand Tour. As for the mobility of skilled workmen, it is likely that it was endemic to Europe on the pattern of German artisans' *Wanderjahre*. Again, no reliable figures are available although several hundred thousand itinerant workman criss-crossing the Continent at any one time does not seem an improbable notion, particularly if we include the migratory flows of settlers and colonists from West to East and North to South. The expanding Russian Empire alone took in over 30,000 migrant craft workers and farmers between 1762 and 1775 as we shall see, and it is said that ten times this number were taken in by Prussia in the course of Frederick II's forty-six year reign.¹⁹ Despite legal penalties to deter enticement, there were in all probability at least 2,000 mechanics from Britain alone moving from job to job in France and Belgium during the early Restoration years.²⁰

The scenario of technical knowledge infiltration through 'multiple networks' and 'diverse media' sketched out by Liliane Hilaire-Pérez and Catherine Verna seems entirely plausible therefore, even if it remains largely invisible to the historian's eye. However, we do know a certain amount about the more formal recruitment and despatching processes that distributed agricultural knowledge, highly reputed estate managers, experienced tenant farmers, skilled field workers, and ingenious artisans around Europe. One of the best documented nodes concerns Arthur Young inasmuch as his surviving correspondence demonstrates quite clearly that his Bradfield estate served both as a reception centre and as a recruitment station. He received promising young men whom individuals or governments on the Continent had designated for practical training and allocated them to the more progressive farms of his neighbours and acquaintances throughout central and southern England. Among the first to benefit from this facility were the La Rochefoucauld brothers, although as the offspring of a peer of the realm they used their stay in England and Scotland to harvest useful information rather than to patrol the fields and acquire transferable manual skills. Nonetheless, they shed precious light on the mechanisms of Agricultural Enlightenment, recording in the aftermath of a visit to Dishley in Leicestershire, for instance, that the stock-breeder Robert Bakewell had two Russian farm apprentices in residence.²¹

Arthur Young recruited and despatched estate managers and skilled farm workers for employment abroad as well. They included his own son who was enlisted in 1805 to carry out an agricultural survey of the 'government' or province of Moscow. Emperor Alexander I subsequently rewarded him with a large tract of land in the Crimea. In similar fashion Sir John Sinclair used his good offices to spread far and wide the human capital of the Scottish Enlightenment. In Russia it was chiefly the autocracy which took in hand the procurement of resources for agriculture,

¹⁹ Roger Bartlett, *Human Capital: The Settlement of Foreigners in Russia, 1762–1804* (Cambridge, 1979), pp. 66–7; David Blackbourn, *The Conquest of Nature: Water, Landscape and the Making of Modern Germany* (London, 2007), pp. 46–7.

²⁰ John H. Weiss, *The Making of Technological Man: The Social Origins of French Engineering Education* (Cambridge, MA, 1982), p. 8.

²¹ 'We saw staying here a young man the Empress of Russia had sent to spend some years studying English agriculture. There are two of them: the other was out in the fields', Scarfe, *Innocent Espionage*, p. 33.

although great magnates such as Prince Potemkin ran parallel operations to attract skilled migrants. Potemkin, who became Governor-General of Taurida in 1774, employed the recruiting agent Georg von Trappe to re-populate the Ukraine with German Mennonite settlers drawn principally from the Danzig region.²² The Sierra Morena, by contrast, was reinvigorated with catholic farmers drawn from Alsace-Lorraine and the south-western German states. The declared aim of Campomanes and his collaborator Olivade was to bring in more progressive and technologically advanced cultivators of the soil in order to raise the sights of the local population. In this instance the recruiting agent was a Bavarian soldier of fortune named Johann Caspar von Thurriegel. Although nearly eight thousand recruits had been assembled by the summer of 1769 the hot and dusty experiment in Agricultural Enlightenment on the uplands of western Andalusia was not an immediate success and the ranks had to be supplemented with native Spanish smallholders (from Catalonia rather than Castile) which partly undermined the object of the exercise.²³ In France the government seems only to have played a minor role in recruitment, leaving it to the market and a number of individuals operating in the shadows to channel the flow of skilled operatives into the country. We know, for example, that in 1761 a certain 'Sieur Wodehouse, négociant à Dunquerque' was responsible for bringing over from England three female dairy workers with expertise in cheese-making and the preparation of salt butter for naval use.²⁴

Russia's attempt to improve her agricultural economy by 'buying in' foreign expertise was sustained over several decades. It enjoyed some success, particularly in the lower Volga and the new borderlands of southern Ukraine from which Tartar farmers had been ousted, creating an opportunity to reorientate the rural economy. Although the interventions of Catherine II were mainly 'populationist' in motivation, the Chancellery of Guardianship ensured, in 1763, that instructions were sent out to encourage the peopling of the empty spaces of the Empire with 'husbandmen and agricultural workers'.²⁵ The recruitment net was cast wide and it caused some annoyance in European capitals. A batch of would-be migrants which included 'real husbandmen' was sent by the diplomat Alkesei Semenovitch Musin-Pushkin from Hamburg, but the efforts of the Russian Minister in London, Count Alexander Vorontzov, were stymied by the British government. Even so, a contingent of farmers from Württemberg and the Palatinate reached the Ukraine in 1766, bringing with them improved German ploughs and an aptitude for tobacco and madder cultivation. Progress was slow, though, and it was only after a decree of 1804 aimed at more specialized migrants 'having in general all necessary knowledge of the best agriculture',²⁶ that it started to register in parts of New Russia where sericulture, viticulture, and merino sheep grazing began to flourish.

²² Bartlett, *Human Capital: the Settlement of Foreigners in Russia*, p. 127.

²³ Paul J. Hauben, 'The First Decade of an Agrarian Experiment in Bourbon Spain: The "New Towns" of Sierra Morena and Andalusia, 1766–76', *Agricultural History*, 39 (1965), 34–40; also Herr, *Rural Change and Royal Finances*, pp. 38–40.

²⁴ Bourde, *Agronomie et agronomes*, iii, p. 1523.

²⁵ Bartlett, *Human Capital: The Settlement of Foreigners in Russia*, p. 59.

²⁶ Bartlett, *Human Capital: The Settlement of Foreigners in Russia*, p. 197.

Contemporaries were generally agreed that the German colonist villages set high standards and pioneered innovatory practices. However, the calculation that they would re-energize native Russian agriculture rarely seems to have paid off, at least not in the heartlands of the Empire. Towards the end of the century the botanist and traveller Johann Georgi recorded the observation that, 'the German colonists who inhabit villages in various districts have indeed established themselves after the manner of the German countryside; but with the passage of time they are gradually adopting more and more from Russian agriculture. The Russian country folk on the other hand copy them in almost nothing'.²⁷ The alternative was to send out personable lads to be trained on English or Scottish farms in the expectation that they would demonstrate the efficacy of the new husbandry on their return to the motherland. But when this was tried by Empress Catherine in the mid 1770s it turned into an expensive fiasco. A correspondent to the *Annals of Agriculture* who claimed to have direct knowledge reported that three individuals had been sent over at a cost to the Russian treasury of 2,400 guineas who, on their return in 1784, had been required to demonstrate their newly acquired skills. Those present at the trial raised serious doubts about 'their capacity ever to produce a striking likeness of a glimmer of English husbandry'—one of the imputations being that Catherine had allowed her advisors to select for the assignment already grown men with airs and graces ('I never yet thought ruffles any ornament to the plough handle'). It would have been far better to have despatched sturdy youngsters with less money jangling in their pockets.²⁸

The report confirmed Arthur Young in his belief that the establishment of agricultural colonies with an adrenalin injection, so to speak, of foreign expertise was never likely to work in Russia where serfdom prevailed and all peasants were, in effect, tenants-at-will with a duty to perform labour service. This, in spite of the fact that he had been closely involved in organizing the exchange. In reality rather more than three students would participate in the experiment and several would go on to hold high positions. The priest and future diplomat A. F. Samborski left Young's house in Suffolk in 1779 laden with ploughs, harrows, and all sorts of agricultural goods. They were to be used on a model farm near Tsarskoye Selo where the trainees were expected to show off the skills they had acquired whilst abroad.

As we noted in chapter two Frederick II of Prussia also came to the conclusion that the training of enthusiastic beginners was less cost-effective than buying in tried and tested operatives. In 1769 an English tenant farmer named Christopher Brown was granted the lease of a Crown estate having previously been employed on the properties of the Kameke family to the north-east of Berlin. Presumably the Pomeranian nobleman Paul Friedrich von Kameke had brought Brown back with him following a tour of Great Britain. Brown was able to establish a version of the Norfolk Four-Course Rotation (manured turnips, barley under-sown with clover, clover or legumes, rye or wheat) on some of the Kameke farms, and then proceeded with virtually identical improvements on the Crown estate of Mülhenbeck. Turnip

²⁷ Bartlett, *Human Capital: The Settlement of Foreigners in Russia*, pp. 76–7.

²⁸ *Annals of Agriculture*, 16 (1791), 327.

seed, a skilled ploughman, and a wide variety of implements were all brought in from England. In fact, he seems also to have set up a workshop to copy and distribute harrows and swing ploughs to the tenants of neighbouring Crown estates. But farming on this scale required a substantial capital cushion and after the calamitous harvest of 1772, which produced economic repercussions all over Europe, Brown ran into serious financial difficulties. Other problems arose as well which seem to have been peculiar to the employment of skilled British artisans abroad, whether in agriculture or in the manufacturing sector. They were not as pliable and subservient as their employers would have wished and proved hard to tie down (Brown fled, in fact, leaving debts behind). As the son of his first Prussian employer would remark whilst acknowledging the policy dilemma facing authoritarian governments, 'it is always dangerous for a foreigner to bring in innovations, however useful'.²⁹

Innovation generally involved a trade-off of some description and in the servile lands of central and eastern Europe, political and cultural considerations weighed heavily. After the ending of the Napoleonic Wars large numbers of Scottish and English tenant farmers and skilled artisans were encouraged to emigrate to Congress Poland. Brigadier-General Ludwik Michał Pac established a colony of about 500 such individuals on his estate at Dowspuda in the 1820s where he also had a palace erected in the English Gothic-revival style. Although Pac would go into exile following the 1831 uprising and never returned to reap the benefits of his improvements, it appears that a viable cheese-making industry survived, not to mention many alterations to the agrarian landscape and to cropping practices. The 'Cheshire' cheese of Dowspuda was highly prized as late as 1856.³⁰ Pac's innovations embraced an end to servility and labour services (two-thirds of his peasant farmers were issued with contracts) which in Russian-occupied Poland limited somewhat the wider appeal of his agricultural reforms. Yet we know that this enlightened-landowner approach to modernization resulted in quite a number of initiatives in the immediate post-war years. At Turew in Wielkopolska Baron Dezidery Chłapowski threw himself into farming after a brief practical introduction to English and Scottish agriculture in the summer of 1818. The import of skilled personnel, notably a mechanic and a farm steward from Scotland, as well as the very latest hand-tools and machines was integral to his schemes for the renovation of the vast Turew estate (see p. 199)—as he would explain in his own work of agronomic propaganda in support of British-style farming.³¹ From the 1830s British tenant farmers began to colonize the Zamoyski properties on the Vistula as well.

French policymakers of the early nineteenth century worried incessantly about the erosion of the skill base of the nation in the aftermath of the Revolution and the abolition of the guilds.³² A concerted effort was made under the Directory and the Empire, therefore, to attract entrepreneurs, foremen, and specialist craftsmen

²⁹ Müller, 'Christopher Brown—an English Farmer in Brandenburg-Prussia', 128.

³⁰ Julian Bartyś, 'English and Scottish Farmers in Poland in the First Half of the 19th Century', *The Agricultural History Review*, 15 (1967), 102.

³¹ Dezidery A. Chłapowski, *O Rólnictwie/On Agriculture*, 4th edn. (Poznań, 1875); see also Ewa Konieczna, 'The Influence of the British Pattern on the Agricultural Work of Dezidery Chłapowski', *Polish-Anglosaxon Studies*, 2 (1991), 69–78.

³² See John R. Pannabecker, 'Inventing Industrial Education: The *Ecole d'Arts et Métiers* of Châlons-sur-Marne, 1807–1830', *History of Education Quarterly*, 44:2 (2004), 225.

which the Bourbons took over more or less intact on their return to power in 1814–15. The modernization of agriculture by this time had slipped down the political agenda and the best-documented example of skill mobility and technological diffusion belongs more properly to the period of the late *ancien régime*. Having inherited the estate of Liancourt from his father in 1789, the Duke de La Rochefoucauld resolved to convert the holding at Louveaucourt into what became known subsequently as 'la ferme anglaise'. No doubt Maximilien de Lazowski, tutor to his two sons during their sojourn in Britain, had something to do with the decision. Perhaps also Arthur Young who was invited to inspect the farm shortly before returning to England after his third French tour: he certainly supplied the duke with the contacts needed to recruit suitably qualified farm workers.

A Suffolk tenant farmer named Richard Reeve agreed, rather late on in life, to go out to France and run the farm as a paid manager or steward, and it is largely through his meticulous bookkeeping that we are able to reconstruct the story. When he signed the contract to take over the farm in May 1790, it consisted of about 120 acres of arable and 25 acres of meadow, all enclosed with fences and ditches, plus around 9 acres of wood and wasteland. The new manager brought with him his family, a labourer, five oxen, with one bull and five cows from Sussex and an additional polled bull and five cows from Suffolk. The training of locals in the use of English ploughs and farm tools began immediately, while female domestic servants were taught the rudiments of dairy management. Two young lads meanwhile were sent back to Suffolk to learn on the job as farmhands. Reeve married (or remarried) in the village which must have smoothed his path towards acceptability quite considerably. At all events we know that the farm animals would be greatly improved by crossing and that he had a crop of cabbages and turnips in the ground by 1792 which had never been seen in the district before. Young claimed that several neighbouring farmers were sufficiently impressed to enclose their own land and adopt English-style tools, although on what evidence (he left France in January 1790) is not at all clear. Following the departure abroad of the duke the 'English farm' was confiscated, however, and by 1795 it belonged to Jacques Isoré, a local notable with progressive farming credentials and a politician who had done well out of the Revolution. Richard Reeve seems to have remained in residence at Louveaucourt, though, for he was rediscovered by the duke on his return from emigration in 1799.³³

Generally speaking the best evidence for the circulation of skills and agricultural implements via labour mobility comes from England and Scotland. The evocation by T. C. Smout of the 'trickle of skilled Englishmen'³⁴ who carried techniques into Scotland at the behest of the nobility and gentry reminds us that the internal circuits of Agricultural Enlightenment were every bit as important as the pan-European flows. From the 1760s Norfolk farmers were being brought in routinely by Scottish landlords, the aim being to assess the potential for the improvement of their estates and to set an example. These were well-educated tenant farmers for the most part:

³³ A. D. Oise 1Q2⁴; 1Q3531; La Rochefoucauld, Wolikow, and Ikni, *Le Duc de La Rochefoucauld-Liancourt*, p. 106; René Mantel, 'La Rochefoucauld-Liancourt: un novateur français dans la pratique agricole du XVIII^e siècle' in Rigaudière, Zylberman, and Mantel, *Etudes d'histoire économique rurale au XVIII^e siècle*, pp. 188–203.

³⁴ Thomas C. Smout, *A History of the Scottish People, 1560–1830* (London, 1969, 1985), p. 274.

the two individuals recruited by the guardian of the Duke of Buccleuch in 1760 were described as 'men of character and substance'³⁵ and they travelled north to Dalkeith with servants. Knowledge and skill transfer at less exalted levels could be more problematic though. When James Hutton took over his father's farm of Slighhouses in Berwickshire he acquired both a Norfolk plough and a ploughman only to discover that Berwick and East Anglian farmhands were not able to communicate effectively, with the result that the Norfolk ploughman failed to train a successor before moving on.³⁶ Yet where incentives to change existed, culture and language proved no insuperable barrier to 'learning by doing'. In 1790 Berwickshire reapers rebuffed the blandishments of local farmers who offered to provide them with scythe hooks to use in the place of their sickles—until, that is, non-native harvesters demonstrated the greater workload that could be achieved by switching tools.³⁷

As we shall see, the capacity of new implements to bring about productivity-enhancing technological change remained latent in the absence of individuals capable of demonstrating their use. This was particularly true of the scythe which came in many shapes and sizes. Following a visit to Cumberland from his north Yorkshire parish the Rev. Benjamin Newton noted in his diary, 'My man who mows as they do down in the South without ever quitting the stooping attitude could not make near such good work but had to mend it every time as the strait scythe left a piece of grass standing almost every stroke he took'.³⁸ Skill and tool design counted, then, and it was incremental as Stuart Macdonald points out, 'when labourers took technological change with them from one region to another, they carried not just the information they themselves had received, but also that which they added to make the innovation successful'.³⁹

HAND-TOOLS AND MACHINES

Contenders for the premiums of the London-based Society for the Encouragement of Arts were required to submit blueprints of their inventions together with the actual machine, or a scale model, which in due course would be put on public display in the repository room. In 1772, at the behest of the Society, William Bailey published a selection of illustrations of agricultural tools or implements that had been awarded prizes. He assured readers that 'care has been taken to represent not only the whole machine, but every part of it, in such various points of view, as to enable the artisan to construct it from the description'.⁴⁰ Subscribers to his two

³⁵ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', p. 40.

³⁶ Jean Jones, 'James Hutton's Agricultural Research and his Life as a Farmer', *Annals of Science*, 42 (1985), 573–601.

³⁷ Stuart Macdonald, 'Agricultural Improvement and the Neglected Labourer', *The Agricultural History Review*, 31 (1983), 87.

³⁸ Macdonald, 'Agricultural Improvement and the Neglected Labourer', 88.

³⁹ Macdonald, 'Agricultural Improvement and the Neglected Labourer', 87.

⁴⁰ William Bailey, *The Advancement of Arts, Manufactures, and Commerce or Descriptions of the Useful Machines and Models contained in the Repository of the Society for the Encouragement of Arts, Manufactures, and Commerce* [...] 2 vols. (London, 1772), i, preface.

volumes of copperplate engravings included J.-C.-P. Trudaine de Montigny, the French *intendant de commerce*; Count Karl August von Hardenberg, the future Prussian reform minister who would bring Thier to Möglin; Karl Friedrich Margrave of Baden, the German disciple of the physiocrats; the anglophile Princess Ekaterina Dashkova who became the director of the Saint-Petersburg Academy of Arts and Sciences; and João Hyacintho Magalhães, the Portuguese savant and professional knowledge disseminator.⁴¹ An extensively revised catalogue containing no fewer than 106 copperplates of agricultural implements appeared a decade or so later.⁴²

Model rooms and cabinets of machines were intrinsic to the expression of Agricultural Enlightenment in Europe. The Highland Society's collection of new and improved implements became so voluminous that in 1840 it was moved to a separate site in Edinburgh and the following year was opened to the general public. We might question the impact of such static displays and wonder whether meticulously illustrated catalogues which seemed to offer quick access to the latest industrial technology ever played much of a role in the diffusion process. Yet contemporaries had huge confidence in their utility. In the face of the seemingly infinite power of Nature, even the smallest improvements to tools and basic, everyday machines were highly prized. Albrecht Daniel Thier, we know, commissioned local Hanoverian craftsmen to produce viable imitations of both Small's modified 'Rotherham' or chain plough and Duckett's trenching plough, which had received the accolades of the Society in 1769.⁴³ Similarly the Danish statesman and landowner Count A. P. Bernstorff wrote to Sir John Sinclair, president of the Board of Agriculture, to praise the County Reports, instancing in particular the engraved plates of agricultural implements they contained.⁴⁴ The inference, in both cases, was that tried-and-tested models would help to standardize agricultural technology and eradicate aberrant local practice. The French took such sources of information very seriously indeed. In fact during the long-running geo-political conflict of 1793–1815 they accused their English adversaries of an unconscionable breach of Enlightenment civility in publishing the technical specifications of steam-powered machines that could *not* be replicated from the diagrams and instructions accompanying them.⁴⁵

Although experimentation with the use of steam in agriculture began in the 1830s when the first attempts to attach a plough to an engine were tried out in

⁴¹ Based in London from the early 1760s, he would be described by the steam engineer James Watt as 'by profession a dealer in and retailer of philosophy, and perhaps a Spy', see Eric Robinson and Douglas McKie (eds), *Partners in Science: Letters of James Watt and Joseph Black* (Cambridge, Mass., 1969), p. 78.

⁴² Max L. Kent, 'The British Enlightenment and the Spirit of the Industrial Revolution: The Society for the Encouragement of Arts, Manufactures and Commerce (1754–1815)' (PhD dissertation, University of California, Los Angeles, 2007), p. 110 note 56.

⁴³ Allan and Abbott, *The Virtuoso Tribe of Arts and Sciences*, p. 249.

⁴⁴ *Communications to the Board of Agriculture*, i, 304.

⁴⁵ In the course of a discussion about the ubiquity of workshop steam engines in England as compared to France, the chemist Philippe Gengembre commented, 'que l'on tenterait en vain l'usage de machines dont ce peuple, jaloux de son industrie, publie des descriptions; que les parties essentielles du mécanisme y sont toujours tronquées, et qu'il serait impossible de construire d'après les gravures qui les accompagnent', *Bulletin de la Société d'encouragement pour l'industrie nationale*. 4^e année. (Messidor an XIII–Juin 1806), 225.

the field, the revolution in labour productivity brought about by this new technology scarcely belongs to the story of Agricultural Enlightenment. Ploughing before the middle of the nineteenth century involved animal traction (supplied by horses and oxen, more rarely cows and mules) and a wide variety of locally designed and constructed implements made mainly of wood which either traced a narrow wedge-shaped incision in the soil or turned it over. Stick ploughs were commonplace in southern Europe and did little more than scratch the surface, necessitating repeated passages in order to prepare the ground adequately for sowing. The American traveller William Maclure dubbed such ploughs antiques 'as near to a forked tree as can be'.⁴⁶ On the basis of observations made near Montpellier in 1807 he reckoned that they cut about two inches deep.⁴⁷ But even the more sophisticated implements equipped with mouldboards which turned over the soil on one side only to form a furrow rarely penetrated deeper than four inches if we are to believe survey evidence from northern France dating ostensibly to the 1780s.⁴⁸ The main difference between English and continental ploughs, noted François de La Rochefoucauld, was that the former had no wheels and were partly constructed of iron. However, when Thomas Malthus travelled through Sweden at the turn of the century, he observed the operation of a light swing plough with no wheels being drawn by a single horse.

There was no such thing as a single improved plough design as innovators soon realized, although the tendency simply to ape the machine technology viewed at first hand in England and Scotland or else copied from technical manuals bedevilled attempts to modernize agriculture on the Continent for decades. Different ploughs served different purposes depending on whether the soil was light or heavy or stony, whether arable fields were ploughed flat or in ridges to facilitate drainage, and depending on what crops were to be planted. Root crop seedlings such as sugar beet or seed turnips necessitated deeper ploughing. Wheeled machines which were omnipresent throughout north-eastern France and Germany tended to produce better results in the hands of relatively unskilled operatives, but they made heavy weather of wet and clinging clay soils. Eric Kerridge makes the point about diversity particularly well when he emphasizes that ploughs were made locally in response to local conditions: 'thus there were wheel-ploughs, and ploughs without wheels, ploughs with a foot for sliding over sticky land, and swing ploughs that could hold themselves down in heavy soil; fen-ploughs with disc coulters and broad-finned shares, turn-wrest ploughs for hillsides, light ploughs for sandy soils, drag-ploughs for thin ones, trenching ploughs for drains and breast-ploughs for pushing to pare off the turf'.⁴⁹ Even the use of iron fittings in plough design, which is usually taken as a rough measure of technological improvement, might be a response to purely local circumstance. Iron was routinely employed for the mouldboards of ploughs in the mining areas of Dalarna (central Sweden) from the 1730s, but the innovation did not spread more widely

⁴⁶ Doskey, *The European Journals of William Maclure*, p. 588.

⁴⁷ Doskey, *The European Journals of William Maclure*, p. 102.

⁴⁸ A. D. Oise 6Jp 14 Chartier de Liancourt, agricultural questionnaire [n. d.].

⁴⁹ Kerridge, *The Farmers of Old England*, p. 37.

until the 1800s when Sweden lost the British market for wrought iron and metal prices plunged.⁵⁰

A great deal of tacit knowledge was embedded in effective plough use quite apart from the merits of the implement as a construction made of wood and metal. The Swedish iron mouldboard ploughs were heavy and hard to manoeuvre, but they were popular with peasant farmers because they cut through the sod cleanly and offered notable economies in terms of animal traction. The first plough to incorporate abstract scientific principles into its design was probably that of William Small which was perfected around 1765. Small took the so-called Rotherham plough as the template for his research and development, in other words a plough design which seems originally to have been imported into England from Holland in the 1730s. Using a model he focused his attention on the profile of the (wooden) mouldboard and measured the angles of the furrow slice as it passed along the board before being inverted. This enabled him to calculate on a scale the necessary width and curvature of the mouldboard when a cut of a certain depth and a furrow of a certain width were required.⁵¹

But the 'perfectly' efficient plough belonged to the realms of theory. The most that could be expected was a technology optimized to cope with a given set of conditions. Even in England and Scotland Small's plough spread rather slowly. It was generally less robust than country ploughs, prone to damage by stones and offered no real advantage where the cultivation platforms or ridges were raised high or were crooked in shape. The cumbersome traditional plough pulled by four oxen and two horses remained the implement of choice in 40 per cent of Scottish parishes around 1800; only 27 per cent of parishes reported a definitive switch to Small's improved version of the 'Rotherham' base model.⁵² In any case it is important to emphasize once again that enhancements to prevailing technologies secured acceptance, generally speaking, only when introduced as part of an ensemble of changes. Following a process of research and development reminiscent of the experiments carried out by Small, C.-J.-A. Mathieu de Dombasle announced in 1819 the invention of a French version of the swing plough which dispensed with the need for wheels—a source of clogging and consequently of friction in the heavy clay soils of Lorraine where it was developed. Yet when the machine was sent to Paris for trials, the Société Royale et Centrale d'Agriculture could not make it work properly. Mathieu de Dombasle therefore despatched his most skilled ploughman Bastien, foreman of the Roville farm. But even Bastien, operating with two harnessed horses that did not recognize his voice or his movements and gestures, was unable to demonstrate its advantages to the full.⁵³

⁵⁰ Carl-Johan Gadd, 'The Agricultural Revolution in Sweden, 1700–1870' in Janken Myrdal and Mats Morell (eds), *The Agrarian History of Sweden: 4000 BC to AD 2000* (Lund, 2011), p. 146.

⁵¹ See James Small, *A Treatise on Ploughs and Wheel Carriages* (Edinburgh, 1784) as recounted in G. E. Fussell, 'Ploughs and Ploughing before 1800', *Agricultural History*, 40:3 (1966), 184.

⁵² Devine, *The Transformation of Rural Scotland*, p. 154.

⁵³ *Mémoire sur la charrue considérée principalement sous le rapport de la présence ou de l'absence de l'avant train par C.-J.-A. Mathieu de Dombasle... suivi de deux rapports faits à la Société, par M. Héricart de Thury* (Paris, 1821), pp. 103–17.

It is tempting to conclude with Kerridge⁵⁴ that plough design did not make much of a difference in the long run, not in England and Scotland at any rate. Yet many continental emulators took a very different view and went to considerable lengths either to import 'Rotherham' ploughs and their hybrids, or to domesticate the largely British technology involved in the manufacture of curved cast-iron mouldboards. The case of Denmark where Small's plough was first brought into the country in 1803 for a ploughing competition provides examples of both processes.⁵⁵ No one seemed in any doubt that the improved designs represented an economy both in terms of farm labour and draft animals, albeit at the price of a higher initial outlay. Both the cost-benefit dimension and the innovation process in respect of new plough designs have been investigated by Liam Brunt⁵⁶ who finds persuasive evidence that improved technology did, in fact, make it possible to plough more acres in a day with fewer draft animals.

Whereas the story of the early modern plough is one of relatively minor incremental improvements, harvesting hand-tools and advances in the technology of grain-threshing offered much greater scope for a step change in the productivity of the rural economy. This scope was being realized by the time Agricultural Enlightenment was drawing to a close. On the basis of data he gathered at the turn of the century Albrecht Daniel Thaer reckoned that a labour saving of between 25 and 30 per cent could be achieved if a scythe were employed to harvest cereals rather than the more usual implement of the sickle.⁵⁷ Normally the scythe was only used to cut low-growing forage crops such as clover and, above all, meadow grass for haymaking. Other near contemporary sources were broadly in agreement: a labourer equipped with a scythe could more than double the area harvested by a man using a sickle.⁵⁸ In the English countryside the scythe had largely ousted the sickle by 1850, and this appears also to have been the case among the big rye and wheat producers of Germany east of the Elbe. In Sweden, which was self-sufficient in both the raw materials and the advanced technology required to make scythe blades, harvesting arable crops using scythes began very early and had eradicated sickle-use by 1850 or thereabouts as well. In France, on the other hand, the sickle remained the predominant harvesting tool well into the nineteenth century.

The slow, or rapid, diffusion of the scythe as a harvesting tool involved several explanatory threads that need to be disentangled. Institutional restraints undoubtedly played a role in restricting scythe use in France just as they complicated decisions to plant fodder crops. Farmers producing cereals on the open fields of Picardy were deterred from employing scythe-carrying harvesters by the law courts which claimed to be acting on behalf of the rural poor. Although the Royal Council

⁵⁴ Kerridge, *The Agricultural Revolution*, p. 35.

⁵⁵ See Christensen, 'Physiocracy—The Missing Link?' in Sundberg, Germundsson, and Hansen (eds), *Modernisation and Tradition*, pp. 85–7.

⁵⁶ Liam Brunt, 'Mechanical Innovation in the Industrial Revolution: The Case of Plough Design', *Economic History Review*, 56:3 (2003), 444–77.

⁵⁷ Blum, *The End of the Old Order*, p. 132.

⁵⁸ George Grantham, 'La Faucille et la faux: un exemple de dépendance temporelle', *Etudes rurales*, 151:151–2 (1999), 104.

intervened in 1785 to overturn the ruling of the Parlement of Paris, it was not until the Revolution and the passing of more secure freehold property legislation in 1791 that landowners began seriously to contemplate the use of the scythe as a harvesting tool.⁵⁹ After all, there were other factors to be borne in mind: the scythe cut low and, when used to harvest rye or wheat as opposed to oats or barley, tended to spill the grain.⁶⁰ On former manorial estates east of the Elbe this was less of a problem inasmuch as land on which to grow grain commercially as opposed to labour with which to harvest it was not in short supply. Significantly, sickle-use lingered on in east German peasant-owned farms.⁶¹ Yet in Sweden, where speed (owing to climate) and the relatively high cost of seasonal labour (owing to competition from mines and ironworks) were important considerations, smaller farmers adopted the scythe every bit as swiftly as big farmers.

Other factors should not be discounted either. Where cereals were grown in stony soil on long and steep ridges, mowing with a scythe was scarcely a feasible option. Supply factors entered the innovation—diffusion equation, too. Whilst knowledge of the potential of the scythe as a tool for harvesting must have been widespread, the technology involved in bulk manufacture of the high-performance laminated blades was not.⁶² It is probably true to say that only in England and Sweden could the domestic iron industry keep up with the metallurgical needs of agriculture. Every other country in Europe was reliant on the international market to some degree. The main centre of the continental scythe and knife-blade industry had long been located in Upper Austria and Styria where a dense concentration of smithies produced for export around 600,000 blades per annum in the eighteenth century.⁶³ Whenever European war broke out supply routes were apt to be disrupted with the risk of knock-on consequences for the rural economy.

France did not have a native blister-steel industry capable of meeting the routine needs of agriculture and in normal conditions she imported around 100,000 blades each year.⁶⁴ These were chiefly scythe blades since sickle blades required less artisanal skill and serviceable tools could usually be made by village blacksmiths if metal was available. Unsurprisingly, therefore, the country faced a prolonged period of shortages when war resumed in 1792 and cut access to the usual sources of supply. The solution adopted during the Revolution was to harness resources and savant

⁵⁹ Weulersse, *La Physiocratie à l'aube de la Révolution*, p. 95.

⁶⁰ On returning to his much depleted estate of Liancourt after the Revolution, the Duc de La Rochefoucauld experimented with a short-handled scythe only to discover that 'la secousse du coup de la faux donne lieu à un égrenage', see Mantel, 'La Rochefoucauld-Liancourt un novateur français', p. 158.

⁶¹ Philippe Braunstein and Erich Landsteiner, 'The Production and Trade of Steel and Steel Tools in the Early Modern Semi-Periphery: a Commodity Chain Approach to the Innerberg District (Austria) in the 16th and 17th Centuries', in Philippe Dillmann, Liliane Pérez, and Catherine Verna (eds), *L'Acier en Europe avant Bessemer* (Toulouse, 2011), p. 441.

⁶² M. Joan Unwin and Marion E. Unwin, 'An Edge of Steel', in Dillman, Pérez, and Verna (eds), *L'Acier en Europe avant Bessemer*, p. 116. A scythe made of cast-steel was patented in Sheffield in the 1790s, see <http://www.lse.ac.uk/economicHistory/workingPapers> (accessed 6 May 2014).

⁶³ Braunstein and Landsteiner, 'The Production and Trade of Steel and Steel Tools', p. 437.

⁶⁴ *Bulletin de la Société d'encouragement pour l'industrie nationale*. 5^e année (juin 1806–juin 1807), 51.

knowledge in a crash programme of agricultural techno-science.⁶⁵ In the meantime the government sought alternative supplies in Switzerland, but with mixed results. Many skilled metalworkers had been conscripted into the armies and with a prolonged shortfall of agricultural ironmongery, growth suffered a setback. By 1806 a single workshop in the east of France was producing between eight and ten thousand scythe blades a year, yet this fell far short of pent-up demand. Only during the Restoration years was the bottleneck overcome when a partnership formed between a Toulouse iron merchant, a State engineer who had received training at the Freiberg mining academy in Saxony, and a highly experienced German technologist resulted in the establishment of a scythe blade and file factory at Le Bazacle. The production of blades in Toulouse reached 200,000 by 1824 and 300,000 by 1838, by which time scythes were being exported from France to Spain and Italy.⁶⁶

The introduction to the rural economy of 'numberless new-fangled machines' which the sceptical John French Burke⁶⁷ remarked on in 1837 can be traced back to the start of the 1760s. It is nonetheless true that the rate of innovation increased greatly during the Revolutionary and Napoleonic war years when shortages of manpower and *matériel* provided an additional incentive to modify and improve devices which had hitherto only existed on paper, or as scaled-down models. One of the longest and most labour-intensive tasks on the farm was the flailing of sheaves of ripe grain brought in from the fields and in 1788 Andrew Meikle, a millwright from East Lothian, patented the first really effective mechanical thresher. It was probably the existence of this machine which Sir James Hall brought to the notice of the chemist Lavoisier during a visit to Paris in 1791.⁶⁸ Powered either by horse or by water, its use spread rapidly across Scotland, although take-up was more tentative in England where the rural poor viewed the resulting loss of seasonal employment with dismay and opposed its adoption. Nonetheless this did not prevent the machine from being swiftly copied in Scandinavia and elsewhere in Europe. Threshers were being produced in Denmark on the Scottish model from 1806 and we know that by 1814 the Swedish improving landowner, Carl Georg Stjernsward, was both manufacturing them and using them on his estate at Engeltöfta in Scania.⁶⁹ Agrarian reforms in these countries had boosted the quantities of marketable grain resulting in a bottleneck in the chain of production which the mechanical thresher promised to overcome.

Machines like these were hugely expensive to acquire and maintain, of course; far more so than improved ploughs. Their use only made economic sense on very

⁶⁵ 'les despotes de l'Angleterre et de l'Allemagne ont rompu tout commerce avec nous. Eh bien! faisons notre acier', *Avis aux ouvriers en fer sur la fabrication de l'acier. Publié par ordre du Comité de Salut Public* (Paris, [1793]), p. 3.

⁶⁶ René Tresse, 'Le Développement de la fabrication des faux en France de 1786 à 1827 et ses conséquences sur la pratique des moissons', *Annales économiques, sociétés, civilisations*, 2 (1955), 341–58; Jean Cantelaube, 'L'Acierie, usine à faux et limes du Bazacle: Toulouse, ville pionnière d'une industrie nouvelle au XIXe siècle', in Bernadette Suau, Jean-Pierre Amalric, and Jean-Marc Olivier (eds), *Toulouse, une métropole méridionale: vingt siècles de vie urbaine*. 2 vols. (Toulouse, 2009), i, pp. 503–15.

⁶⁷ Burke, *British Husbandry*, ii, p. 2.

⁶⁸ 'Spoke about farming with Lavoisier—he has not heard of the thrashing mill', Chaldecott, 'Scientific Activities in Paris in 1791', 22.

⁶⁹ Lars Magnusson, *An Economic History of Sweden* (London and New York, 2000), p. 13.

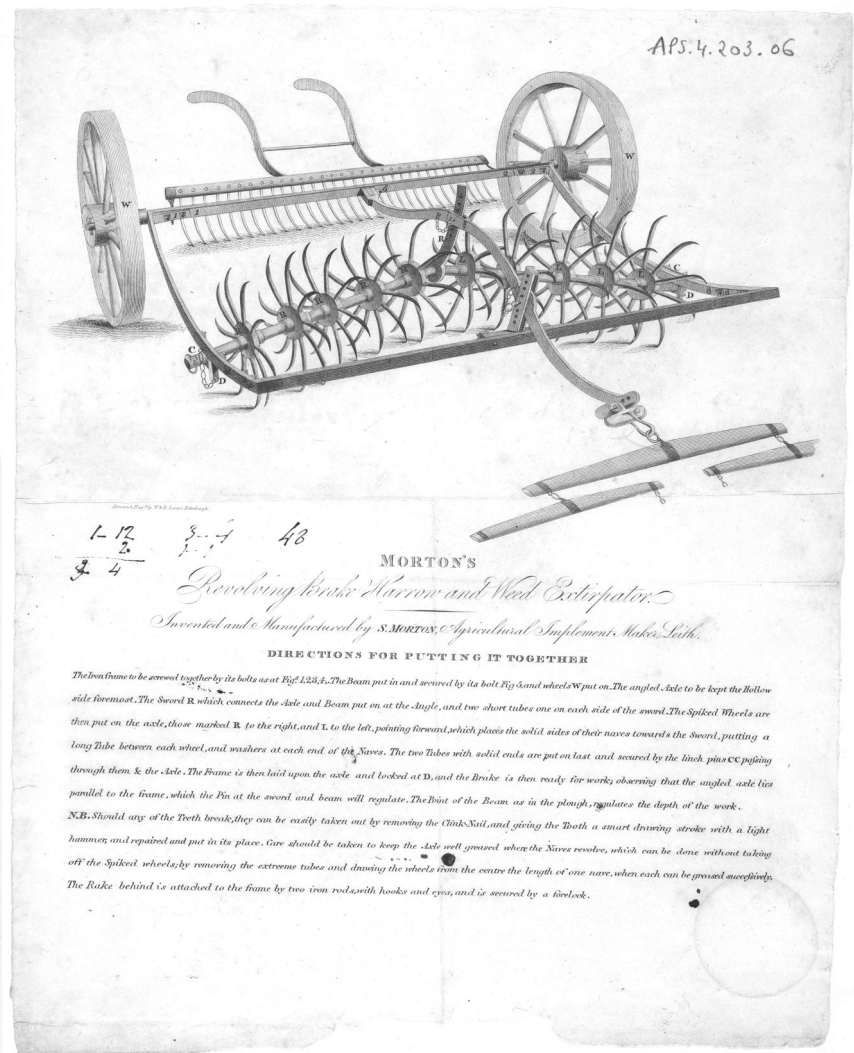


Figure 5.2. Revolving brake harrow and weed extirpator submitted to the Highland and Agricultural Society of Scotland by Samuel Morton, agricultural implement maker.

Source: *The Edinburgh Advertiser*, 31 January 1817. Reproduced by permission of the National Library of Scotland.

large estates. In early nineteenth-century France a property having over 100 hectares under cereals, that is to say harvesting a minimum of 1,500 hectolitres of grain each year, was considered to justify such an outlay.⁷⁰ No doubt this was the reason why Emanuel Fellenberg, the Swiss pioneer of innovative agricultural

⁷⁰ René Bourrigaud, *Le Développement agricole au 19^e siècle en Loire-Atlantique* (Nantes, 1994), p. 230.

technology, favoured the idea of setting up depots in each village which would lend out implements such as weed extirpators, horse-hoes, and seed-drills to smaller farmers. Fellenberg was particularly proud of the multi-tine hoes which he manufactured at Hofwyl in all shapes and sizes. Weeding, like the labour carried out on the threshing floor, was very time-consuming and at risk of becoming more so as the century advanced, animal manure became more plentiful and more and more farmers converted land to potato growing. In 1817 the Highland and Agricultural Society of Scotland rewarded the Edinburgh agricultural implement maker, Samuel Morton, with a silver punch bowl for the invention of a revolving brake harrow which exposed roots in the fallow field while at the same time pulverizing the soil. It is illustrated in Figure 5.2.

The potato was a high-yield but exceedingly burdensome crop to produce in terms of field labour; however cultivation costs could be mitigated if the tubers were planted in neat and well-spaced drills or rows which allowed the passage of a horse-drawn hoe. Drill husbandry had been debated in agronomic circles ever since Duhamel du Monceau had made widely known the experiments of the English innovator Jethro Tull⁷¹ in the early part of the century. Yet drill machines were not taken up very quickly. Count Hans Rantzau tried out the Tull approach on his estate of Ascheberg in Holstein in the late 1760s as we have noted, but he soon relegated it to his vegetable garden. It is not as if there were a lack of models to follow for the drill machine cannot be shown to have been invented by anyone in particular. Rather it represents a good example of an agricultural technology which evolved by a process of constant adaptation. In 1791 a correspondent of Young's *Annals of Agriculture* rebuffed all priority claims, observing 'how this child of so many fathers became naturalised here, and a patent obtained for its protection, I know not'.⁷² Five years later another correspondent noted that in the Staffordshire district where he lived (Pendeford) about a dozen farmers owned drill machines, yet most seed was still sown broadcast. In practice seed drills were only extensively adopted in England in the 1840s and mechanical reapers in the 1880s.⁷³

TRANSFER AND CIRCULATION IN ACTION

The physiocrat writer and political economist Pierre-Samuel Dupont claimed that any new English machine could make its way to France within six months of its launch, a claim which John Harris who devoted an entire book to the subject of technology exchange between Britain and France considered only a slight exaggeration.⁷⁴ The challenge is therefore to understand how the movement of tools, implements, machines, and above all the practices accompanying their use actually

⁷¹ Duhamel du Monceau, *Traité de la culture des terres*.

⁷² *Annals of Agriculture*, 16 (1791), 89.

⁷³ Beckett, *The Agricultural Revolution*, p. 27; Federico, *Feeding the World*, p. 100.

⁷⁴ John R. Harris, 'Law, Espionage, and the Transfer of Technology from Eighteenth-Century Britain', in Fox (ed.), *Technological Change*, p. 130; also his monograph *Industrial Espionage and Technology Transfer: Britain and France in the Eighteenth Century* (Aldershot, 1998).

happened. This requires us to acknowledge that 'transfer' was not an isolated, episodic, or unidirectional impulse, but a process occurring across the whole of Europe as emphasized at the start of this chapter. It also invites consideration of the chronology of technology transfer and circulation. Was diffusion a steady and ongoing temporal phenomenon, or were there certain periods of history which proved exceptionally propitious to the movement of technology? It will be evident by now that Agricultural Enlightenment was one of those 'landslide'⁷⁵ moments, and if we probe a little deeper it should be possible to shed some light both on the circulatory flows and the variables which facilitated or hindered movement.

In the case of the Duc de La Rochefoucauld's hobby farm at Louveaucourt the filiation is quite straightforward. As we have seen the Duke hired an English steward, Richard Reeve, with previous experience as a tenant farmer in Suffolk—no doubt after consultation with Arthur Young. Reeve appears to have bought in many if not all of the farm implements from England, including six iron-shod spades. Baron Dezidery Chłapowski of Turew in Poland, on the other hand, acquired his knowledge of the latest farming practices together with the requisite hardware at source. In 1818 he stayed on the Phantassie estate of George Rennie in East Lothian where a generation earlier Andrew Meikle had been employed to build threshing machinery. He later recorded his admiration for the skill of the estate workers having been able to watch them in the process of building hayricks. Whilst at Phantassie he also learned about the displacement of the old Scots plough with Small's more manoeuvrable instrument, was introduced to the different varieties of turnip and clover, and learned the rudiments of soil analysis.⁷⁶

It is unlikely that these knowledge gleanings and 'hardware' transfers passed into the day-to-day husbandry of receiving countries only to circulate in their original state. Agricultural technology was hybridized technology for the most part. Charles Pictet de Rochemont who played a prominent role in introducing the Brabant plough to Swiss farmers arranged for it to be 'modified and adapted to accord with the habits of the peasants of Geneva'⁷⁷ prior to diffusion. Reproducing machines acquired from elsewhere whilst at the same time customizing them to suit the conditions of the host country was intrinsic to a technological Enlightenment unencumbered by international patent law.⁷⁸ Indeed, innovators eagerly anticipated 'feedback' from users as we might say nowadays and could become impatient if they did not receive it in reasonable time. In 1819 Emanuel Fellenberg wrote reproachfully to the Board of Agriculture to point out that he had despatched, at some considerable expense, specimen hand-implements and machines to London in the expectation that trials would be organized and a technical information exchange take place. In particular, he wanted to know whether his sowing machine was suited to English conditions given that drilling in England was considered a

⁷⁵ *Rural History 2013*, session 4.03 "'God is in the Detail": Agrarian Technology, 1000–1600'.

⁷⁶ Konieczna, 'The Influence of the British Pattern', 73.

⁷⁷ *Bulletin des sciences agricoles et économiques*, 8 (1827), 323.

⁷⁸ In this connection, see Martin L. Weitzman, 'Recombinant Growth', *Quarterly Journal of Economics*, 113 (1998), 331–60.

'very great national object'.⁷⁹ Clearly he was unaware that the Board was moribund by this date.

The Swiss patriarch of Agricultural Enlightenment had set up a workshop in Hofwyl where he manufactured more efficient versions of otherwise well-known agricultural instruments, whether those of his own design or reproductions. Secondary manufacturing, attached very often to the estate of an improving landlord, became an increasingly important channel of diffusion in the early nineteenth century. In fact some of these workshops evolved into veritable tool factories with a regional, even a national customer base. After equipping his estate at Engeltofta with the very latest English and Scottish farm machinery, Carl Georg Stjernsvärd branched out into manufacturing in response to demand in Scania for the improved ploughs and harrows. Between 1803 and 1810 his workers made and sold 749 of the former and 377 of the latter, together with seventeen mechanical threshers and half a dozen other types of mechanical device for field and farmyard use. He called his workshop 'the English Tool Manufactory'.⁸⁰

In Lorraine Mathieu de Dombasle set up a workshop for agricultural tools which became a veritable factory. It proved far more successful commercially than the model-farm operation for which he is chiefly remembered and flourished into the 1870s—all the time adding new designs to its product inventory. It appears that 55,080 machines were built in total, whether in Roville or Nancy to which town the factory moved after the founder's death in 1843. About 60 per cent of the production consisted of ploughs, including a two-share plough introduced in 1872. As early as 1836 there were only eight French *départements* from which no orders for Roville-built machines had yet been received, but the heaviest demand came, as we should expect, from farmers working the fertile but heavy clays of north-eastern France.⁸¹ The Dombasle plough was designed to cut a deep furrow cleanly and was less suited to the drier conditions of the south of the country where a furrow that crumbled, allowing the atmosphere to penetrate was required. In the south west a Toulouse industrialist named Lacroix who was not so much an inventor as an enterprising disseminator of agricultural technology managed to adapt the original Roville design to suit both local ploughing practices and the region's soil conditions.⁸²

Exogenous factors certainly aided the diffusion of improved tools and machines for use in agriculture. As we have already had occasion to observe, prolonged continental and trans-oceanic warfare could open up as many avenues as it closed off. The incursion of French forces into Austria in 1805–06 gave the Imperial government unparalleled access to Styrian and Tyrolean blade-forging technology and, no less important, the skilled manpower to go with it. Marshal Soult, in particular, took note and after the war he lent his support to a consortium seeking to establish a

⁷⁹ *The Correspondence of the Right Honourable Sir John Sinclair*, ii, pp. 422–3.

⁸⁰ <http://sok.riksarkivet.se/sbl/Presentation.aspx?id=20169>; http://www.algonet.se/~sylve_a/engelt_a.htm (accessed 25 April 2014).

⁸¹ *Mathieu de Dombasle sa vie et ses œuvres par Edouard Bécus, agriculteur* (Paris and Nancy, 1874), pp. 65–81; Louis Villermé, *L'Agriculture française: Mathieu de Dombasle, sa vie, ses œuvres, son influence* (Paris, 1864), p. 39.

⁸² Louis Théron de Montaugé, *L'Agriculture et les classes rurales dans le pays toulousain depuis le milieu du dix-huitième siècle* (Toulouse, 1869), p. 610.

scythe-blade works at Saut-du-Tarn, near Albi. The Polish General Baron Dezidery Chłapowski who also served Napoleon with distinction was able to make a success of his first agricultural fact-finding mission to Britain largely thanks to letters of introduction supplied by English and Scottish prisoners-of-war whom he had entertained at the holding depot in Verdun. Chłapowski is an invaluable source of information for he made repeated trips across the Channel in the years after 1813 and on several occasions visited the same estates and farms. On one such tour of inspection, in 1839, he returned to farms he had first visited in 1819: the rotations had not changed, but new tools and machines were in use. As for Small's plough it was by now far more widespread in England, although the design had evolved in the interval with the runner extending from behind the share being replaced with a wheel.⁸³ By this date it is clear that the rustic wheelwright tradition in agricultural technology had come to an end and precision engineering was taking over.⁸⁴ By 1843 the Suffolk toolmaking firm Ransome & Son had almost a thousand skilled craftsmen on its books making a wide range of agricultural implements.⁸⁵

Although military operations might temporarily interrupt the free movement of technology, some governments tried to prevent an international market for machines and industrial skills from developing in the second half of the eighteenth century by banning the export of tools and machine parts and by imposing laws to deter artisans in possession of scarce and tacit knowledge from travelling abroad. On the whole such efforts were ineffective, and in any case only occasionally did they impinge on agricultural technology or the practices connected to husbandry. This is reason why Dupont could be so confident in the ability of the commercial and diplomatic agencies of Bourbon France to attract whatever knowledge, 'know-how', and *matériel* were considered a national priority in the drive for growth and geo-political advantage. Cast-steel technology, without which it was difficult to manufacture the very highest-grade files and blades, eluded France for decades. Or at least, it proved difficult to domesticate a technology capable of producing the metal in industrial quantities. The problem was partly solved by persuading the Jackson family to leave Birmingham in 1814 and set up furnaces in Saint-Etienne. However, the British authorities responded by confiscating the assets the family left behind.⁸⁶

In the occasionally murky world of technology transfer and skilled labour mobility, governments would often employ international adventurers to undertake their recruiting and the more questionable forms of knowledge, equipment, and livestock appropriation. We have already come across the case of Colonel Caspar von Thurriegel whom the Spanish government retained to colonize the Sierra Morena with farmers selected ostensibly for their progressive and industrious outlook. Of the same ilk was Thomas Mante who held a lieutenant's commission in the British army during the Seven Years' War before switching to the service of France in 1773. Apparently he was

⁸³ Konieczna, 'The Influence of the British Pattern', 73.

⁸⁴ Dennis Chapman, 'Richard Clyburn, Agricultural Engineer, and the Uley Cultivator', *Gloucestershire Society for Industrial Archaeology Journal*, (1998), 59–61.

⁸⁵ Christabel S. Orwin and Edith H. Whetham, *A History of British Agriculture, 1846–1914* (London, 1964), pp. 4–5.

⁸⁶ www.lexilogos.com/famille/index_jackson.htm (accessed 28 April 2014).

recruited by the French ambassador to the Court of Saint-James, the Duc de Guines, as a general purpose economic agent and spy. In 1781 he would report on the Fleet at anchor in Plymouth, but there is a suggestion that during a chequered career as a go-between he also took orders from the British government. It is the small part he played in the spread of Agricultural Enlightenment as a man able and willing to source tools and machines and to organize shipments of livestock which is of interest to us, however. Established with the assistance of Trudaine de Montigny, Head of the Bureau of Commerce, on a pastoral landholding in Upper Normandy, he brought over from England, harrows, ploughs, a roller, and a substantial farm cart, together with a shepherd and a large number of sheep and cattle from Herefordshire. By all accounts he was not a practical farmer (he seems to have been a military engineer by training: his steward informed the inspector of manufactures John Holker junior that most of his employer's understanding of agriculture came from reading English-language manuals). However, Mante was nothing if not resourceful and persuaded his French paymasters that he was an authority on the planting of fodder crops and the nurturing of English sheep in penned enclosures.⁸⁷

The export of live sheep was a punishable offence both in England and in Spain. Therefore, any individual or government wishing to master the 'technology' of stock-breeding in order to improve carcass weight, or to domesticate a fine-wool grazing industry with the aid of merinos spirited out of Spain had to indulge in a certain amount of subterfuge. Most European countries were interested in the latter since mutton was not a major item of consumption in continental diets. Moreover, Spanish merino wool was in short supply with the result that prices rose sharply in the second half of the eighteenth century and triggered a great deal of creative thinking and entrepreneurship, particularly in central Europe.⁸⁸ The Swedes seem to have been the first to contrive successfully the shipment of a fine-wool sheep flock from Spain. However the problem which would bedevil so much technology movement in the era of Agricultural Enlightenment swiftly asserted itself, namely the need to 'package' skills with products. In 1724 the entrepreneur involved in the initiative, Chevalier Alstroem, found it necessary to set up two schools for the training of shepherds.⁸⁹ This was a lesson subsequently learned throughout Europe: getting hold of the ewes and the rams was only the start, for a flock deprived of experienced shepherds and their sheep dogs was unlikely to become a lasting addition to the rural economy. In Lombardy the agricultural writer and chemist, Vincenzo Dandolo employed a shepherd who had previously learned the management of merinos on Charles Pictet de Rochemonts's estate at Lancy.⁹⁰

⁸⁷ Helen B. Bates, 'Some Notes on Thomas Mante (alias "Junius"?), *Journal of Modern History*, 4 (1932), 232–4; Bourde, *Agronomie et agronomes*, iii, pp. 1637–44 and notes.

⁸⁸ Patrick Chorley, 'The Shift from Spanish to Central European Merino Wools in the Verviers–Aachen Cloth Industry', in Erik Aerts (ed.), *Textiles in the Low Countries in European Economic History* (Leuven, 1990), pp. 96–104.

⁸⁹ *Bulletin des sciences agricoles et économiques*, 8 (1827), 56.

⁹⁰ Pazzagli, 'From Private Initiative to State Intervention', in Vivier (ed.), *The State and Rural Societies*, p. 233.

The Prussians followed suit in 1748 but without significant results, it appears. The first successful breeding flock to be established in central Europe was Saxon, in 1765, and by the end of the century there were numerous private-landlord as well as State flocks in existence. In fact, Saxony managed to build up a thriving domestic industry based on half a million pure-bred merinos and a million crosses by 1819. The wool was exported through the Leipzig fairs since the country had no domestic woollen manufactures of its own.⁹¹ Both the rulers of Russia and Austria watched these developments with interest, and the Habsburgs were granted permission to import sheep direct from Spain in 1773 and again in 1785. France, meanwhile, had mounted an illicit operation to procure merinos with the aid of a go-between. In 1768 a sheep flock was smuggled over the Pyrenees by an individual named Béliardy, commendatory abbot of St-Florent de Saumur. About a thousand ewes and rams entered the country via Perpignan and were sent on to sites in the interior, notably Montbard where the Comte de Buffon, savant and naturalist, had an estate and Lorraine.⁹² More smuggled sheep arrived in 1774 and 1776, but in 1786 official channels were used in order to purchase 342 ewes and 42 rams and ensure their safe transit from Segovia to the royal sheep farm in Rambouillet. Rambouillet subsequently became the main diffusion centre for the merino breed in France.

It is in this context that we need to view the activities of Thomas Mante. Both before and after 1789 French bureaucrats received regular reports commenting on the qualities of English sheep, whether as fat-stock for butchery or as a source of long-fleece wool. The animals were generally reckoned to weigh double that of the native species, and as knowledge of Bakewell's breeding successes began to circulate in the 1780s efforts to import live sheep for crossing were redoubled. We learn from a livestock sale prospectus issued in 1826 that the French had successfully crossed New Leicesters to produce an animal whose wool particularly suited the needs of the worsted manufacturers of Louviers. The flocks that had the most 'Dishley blood'⁹³ in them were those now well established on the farms of La Faisanderie des Moulineaux and Villepreux just outside Versailles. Britain had her own woollen industry, of course, and one which continued to generate revenue from the export of raw wool. Attempts to introduce Spanish ewes were rather half-hearted, therefore, although George III maintained a small merino flock at Kew, as did a number of aristocratic landowners on their own estates.

During the period of the Enlightenment which immediately preceded the era of farm-labour mechanization and the introduction of mineral and chemically derived fertilizers the role played by the improvement of agricultural technology was scarcely dramatic. Most researchers would describe it as ancillary and incremental. Only in specific cases can the argument be made that technology, understood as the bringing together of innovative artifacts and individuals in possession

⁹¹ Chorley, 'The Shift from Spanish to Central European Wools', p. 99.

⁹² Bourde, *Agronomie et agronomes*, iii, pp. 1626–7.

⁹³ *Bulletin des sciences agricoles et économiques*, 5 (1826), 313.

of 'know-how' relating to the techniques of husbandry, led the way.⁹⁴ Even the beacon rural economies of England and Lowland Scotland retained many traditional features still in the 1830s and 1840s according to Lord Ernle. He claimed that in 1837 the soil was largely cultivated with 'implements heavy in the draught'. 'Harrows', he noted, 'were generally primitive in form, and ineffective in operation, scarcely penetrating the ground and powerless to kill weeds... the only roller was a stone or the trunk of a tree heavily weighted'.⁹⁵ Seed was mostly broadcast and corn cut manually, albeit sometimes with the use of a scythe. Yet no individual observer, or agricultural writer, could hope to provide a truly representative overview of English or any other agriculture at this juncture in the absence reliable statistics pertaining to the rural economy. In this chapter we have concentrated instead on processes: how incremental improvements in agricultural technology occurred; how they were transmitted around Europe; and, where it has proved possible to know, with what result.

⁹⁴ See Dan Ch. Christensen, 'Estimating Arable Production and Productivity in Danish Agriculture during the Age of Reform, 1750–1850', in Bas J. P. van Bavel and Erik Thoen (eds), *Land Productivity and Agro-Systems in the North Sea Area (Middle Ages—20th Century): Elements for Comparison* (Turnhout, 1999), pp. 168–88.

⁹⁵ Cited in George E. Fussell, 'Science and Practice in Eighteenth-Century British Agriculture', *Agricultural History*, 43:1 (1963), 17–18.

6

Agricultural Enlightenment and Agricultural Revolution

The best measure of the robustness of Europe's agriculture in the decades after 1750 is that it responded successfully to the challenge of demographic growth. Between 1750 and 1850 it is estimated that the population increased from a little over 143 million to around 267 million.¹ By the end of the period of Agricultural Enlightenment in other words, the farmers of Europe were feeding, for better or worse, 124 million more mouths than would have been the case at the start. This success was achieved notwithstanding a small overall reduction in the percentage of the workforce engaged in food production—from an estimated 59.5 in the middle of the eighteenth century to 57.0 in 1800 and, more tentatively, around 50.0 by 1850.²

Uninterrupted demographic growth was a new phenomenon in early modern Europe. In the seventeenth century numbers had stagnated and in some instances (Germany, the European parts of Russia) fallen sharply. Whilst growth resumed nearly everywhere in the first half of the eighteenth century, it remained modest and was easily knocked off course by harvest failures, pestilence and civil conflict. When, towards the end of the century, Europeans woke up to the fact that many more mouths now needed to be fed and that this situation was likely to persist for the foreseeable future, it came as something of a shock therefore. The tried and tested response to such pressures was to bring more land into arable cultivation (see pp. 192–3), but there would come a point when the local supply of good land became inelastic and a more innovative approach to agriculture would be required. In the meantime the price of basic foodstuffs in the marketplace began to rise for the first time in decades.

This is the context that produced the forecast of the Scottish economist Thomas Malthus who argued, in 1798, that unchecked population growth would inevitably press against the available means of subsistence with unfortunate consequences for

¹ The figures embrace Scandinavia, Scotland, England and Wales, Ireland, the Netherlands, Belgium, France, Italy, Spain, Portugal, Switzerland, Austria-Hungary and Bohemia, Germany, Poland, the Balkans, and European Russia, see Malanima, *Pre-Modern European Economy*, p. 9 Table 6.

² The figures for 1750 and 1800 are based on England, Austria-Hungary and Bohemia, Germany, Poland, Belgium, the Netherlands, France, Italy, and Spain and for 1850 on Great Britain, Belgium, the Netherlands, France, Spain, Ireland, Denmark, and Sweden, see Robert C. Allen, 'Economic Structure and Agricultural Productivity in Europe, 1300–1800', *European Review of Economic History*, 4:1 (2000), 11–13 and Table 2; Anthony E. Wrigley, 'Urban Growth and Agricultural Change: England and the Continent in the Early Modern Period', *Journal of Interdisciplinary History*, 15:4 (1985), p. 723 and note 32 and Broadberry et al., *British Economic Growth*, p. 195 Table 5.02.

the future (starvation, disease).³ Since farming technology was fixed and incapable of improvement, agriculture when pushed to its ecological limits would succumb to the law of diminishing returns. Malthus predicated his analysis on the tendency of population always to increase and the improbability, to put it no more strongly, that significant efficiencies in land use could be achieved. With the benefit of hindsight it is apparent that his theory was in the process of being invalidated even as he was formulating it. Yet he and the classical economists did draw attention to the population question and to the proposition that demographic change should be considered the prime mover within the early modern rural economy. Growth in agriculture occurred initially in response to population pressures and not the other way round. Most investigators of pre-industrial societies tend to frame the question of agricultural change in these terms nowadays having been influenced by the seminal essay of Ester Boserup the Danish development economist.⁴ Why Europe's population started to rise from around the middle of the eighteenth century remains something of an enigma though. If a revolution in agriculture did not enable demographic growth, what did? In a somewhat circular fashion, historians point to a marked decline in mortality (famine deaths), to the arrival of new crops such as the potato and, perhaps more plausibly, to a lessening of epidemic mortality thanks to sanitary improvements, to inoculation (against smallpox) accompanied by semi-autonomous shifts in the virulence of disease.

Of course, if we look more closely the big picture of a Europe powering ahead from the 1750s starts to lose its clarity. Not all countries managed to expand home-grown agricultural production or else to accelerate grain imports so as to keep within sight of population growth. There were considerable disparities of rural–urban and agricultural–industrial development, too. By 1850 employment in agriculture in Britain had dropped to about 22 per cent, whereas in the nearest continental exemplars, the Netherlands and Belgium, the figures were 44 and 51 per cent respectively.⁵ In France it is estimated that around 52 per cent of the population still found employment in agriculture in the middle of the nineteenth century and a massive 82 per cent continued to live and work in the countryside.⁶ Some historians have detected a 'separating out' of Europe traceable as far back as the later Middle Ages as we have noted. North-western Europe, that is to say those regions with access to the Channel and the southern end of the North Sea, coped with the aftermath of the plague-driven mortality crises of the fourteenth century more successfully than their landlocked continental neighbours. These regions seem to have evolved a distinctive pattern of demographic development as early as 1400, in fact, and they would be the first to break through the ceiling on food resources which Malthus's theory implied. Sustained growth within the agricultural

³ [T. R. Malthus] *An Essay on the Principle of Population as it affects the future Improvement of Society* [...] (London, 1798).

⁴ Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (London, 1993 [1st edn. 1965]).

⁵ Bieleman, *Five Centuries of Farming*, p. 147 Table 3.1; or 23.5% for Britain in 1851 according to Broadberry et al., *British Economic Growth*, p. 195 Table 5.02.

⁶ Bieleman, *Five Centuries of Farming*, p. 147 Table 3.1 and David B. Grigg, *Population Growth and Agrarian Change: An Historical Perspective* (Cambridge, 1980), p. 203 Table 40.

economy was one, but only one, of the factors helping to bring about a Little Divergence⁷ embedded within the Great Divergence that by the early nineteenth century had placed the European West on a unique growth path.

This chapter explores the question of differential development in Europe during the critical and much narrower time frame of c.1750–1840. From the middle decades of the eighteenth century all the countries of Europe without exception experienced to some degree the phenomenon of Agricultural Enlightenment as we have outlined it. In a handful of cases, however, the rapidity of the progress made in overcoming the supposedly immutable constraints of organic husbandry was such that use of the term Agricultural Revolution does not seem out of place. The transition from Agricultural Enlightenment to Agricultural Revolution was not preordained though, nor can it be said that those countries whose agriculture was among the first to modernize would naturally line up in the van of Industrial Revolution. The real economic impact of Agricultural Enlightenment together with its spatial patterning is therefore the issue in the pages that follow. We need to weigh in the balance how far changes to the base structures of agriculture and alterations to farming practices (knowledge, technology, labour, and capital inputs) translated into an enhanced capacity for innovation and improved yields. At this juncture it is also appropriate to consider afresh the role of institutions and markets as factors capable of facilitating or hindering growth and restructuring. The chapter ends with case studies of Denmark and Scotland which demonstrate what could be achieved on the ground when the component parts of Agricultural Revolution were brought together.

PRODUCTION, PRODUCTIVITY, AND ENCLOSURE

The idea that England's agriculture—the original template for Agricultural Revolution—started to diverge from the norm at some point in the seventeenth century draws support from commentators who anatomized the structures of this island nation located on the north-west periphery of Europe in hopes of uncovering the recipe for modernization. After a two-year sojourn which included conversational contact with many well-informed individuals, Maximilien de Lazowski came to the conclusion that England's agriculture had been very little different from that of the Continent in the period before the reign of King Charles I (1625–49). He attributed the manifold signs of prosperity he encountered during his tours in the 1780s to the effects of the enforced residence of landowners on their estates during the Cromwellian Interregnum, and to the fact that a sharp status distinction between town and country had never developed as a consequence. Charles Dupin, another Frenchman who joined the throng visiting Britain from the Continent, albeit in the aftermath of the Napoleonic Wars, offered a different and perhaps more compelling diagnosis. An early practitioner of the discipline of

⁷ See Luiten van Zanden, *The Long Road to the Industrial Revolution*, part two and the discussion in the Introduction.

Statistique, he compared the productive capacity of agriculture in France and Britain on the basis of draught animal power and concluded that the latter could muster more than double the animal energy supply of the former.⁸

Like many visitors from overseas, Dupin was also hugely impressed by the skill levels he encountered in Britain, whether in agriculture or in manufacturing industry. In common with Johann Gottfried Herder and several other German commentators he recognized that England, in particular, 'possessed a number of peculiar advantages' which included 'its maritime position, its institutions, its freedom, its *Kopf*'.⁹ 'Know-how' or skill, and power from draught animals were two key ingredients of labour productivity in the countryside—the yardstick modern historians increasingly employ as a means of measuring and comparing agricultural efficiency. After c.1600 the productivity of labour in British and French agriculture diverged sharply with the result that by 1800 the former had risen by around 73 per cent whereas the latter notched up an increase of only 17 per cent.¹⁰ Indeed, labour productivity by this date was higher in Great Britain than anywhere else on the continent of Europe.

The debate about Agricultural Revolution has not focused solely or even primarily on comparative labour productivity, however. Scholars have been chiefly concerned to know when and how English and subsequently Scottish agriculture departed from the 'extensive' continental pattern and succeeded in raising output on roughly the same quantum of land with a diminishing proportion of the workforce allocated to the business of food production. Parliamentary enclosure used to provide a persuasive answer, both for contemporaries and for historians. Maximilien de Lazowski was in no doubt that the annexation of the commons, the curtailment of open-field farming and the consolidation of farm holdings by landowners acting with the backing of statute law worked an 'immense' change.¹¹ He pointed notably to the eradication of the fallow which appeared to double the surfaces available for arable cultivation, and to the massive jolt that hedging and fencing administered to habit and routine. For Lord Ernle, writing in 1912, it was an article of faith that Parliamentary enclosure had enabled a huge and rapid restructuring of English agriculture to take place.¹² Taken together with sown meadows, the planting of root crops, new rotations, and the introduction of drilling, it defined a period of

⁸ Carole Christen and François Vatin (eds), *Charles Dupin (1784–1873): ingénieur, savant, économiste, pédagogue et parlementaire du Premier au Second Empire* (Rennes, 2009), pp. 158–9. The La Rochefoucauld brothers also commented on the ubiquity of horses during their travels, see Scarfe, *A Frenchman's Year in Suffolk: French Impressions of Suffolk Life in 1784* (Woodbridge, 1988), p. 51.

⁹ Quoted in Berend, *An Economic History of Nineteenth-century Europe*, p. 4; see also the judgement of Johann Wilhelm von Archenholz in 1768: 'Great Britain, this queen of islands, differs so greatly from other countries in Europe, so that it seems as if this curious island does not belong to our part of the world, but to the South Seas', cited in Martin, 'Pens to Progress: Arthur Young's Travel Accounts in German Translation', in Stockhorst (ed.), *Cultural Transfer through Translation*, p. 298.

¹⁰ Beckett, *The Agricultural Revolution*, p. 60 and Wrigley, 'Urban Growth and Agricultural Change', 722–3. See also Broadberry et al., *British Economic Growth*, chapters three and five.

¹¹ 'il bannit les jachères et semble doubler la surface du pays, il éloigne toute routine, il étend la liberté du fermier et le met à même de suivre tout l'essor [sic] de son industrie... les terres doublent souvent de revenu après les clôtures. On ne hasarde pas cette assertion, mais on la donne comme un fait', A. D. Oise 6jp 14 Chartier de Liancourt, 'Etat de l'agriculture en Angleterre [...]'.
¹² Rowland E. Prothero [Lord Ernle], *English Farming Past and Present* (London, 1912), chapter eleven.

'revolutionary' change running from roughly 1760 to 1830. Apart from the onset of Parliamentary enclosure, the date 1760 was convenient on another count: it marked the definitive end to a long period of price stagnation affecting farmers, both in Britain and in the rest of Europe.

The consensus that a revolution had overtaken English agriculture in the decades following 1760 persisted until the early 1960s. After all, there existed a wealth of contemporary evidence, or assertion, that rents had risen in the immediate aftermath of enclosure which appeared to indicate that land was now being used more intensively and productively. In his address to the Board of Agriculture of 1797, Sir John Sinclair acknowledged that land rents had advanced very considerably since 1750, particularly in the hinterland of the big manufacturing towns. He also acknowledged that before this date farming and farmers had been in a 'wretched and distressed condition'.¹³ However, as confidence among agricultural historians that enclosure by Act of Parliament marked the turning point began to ebb, the chronology and even the reality of an Agricultural Revolution which preceded and helped to kick-start Industrial Revolution was thrown into disarray. By the end of the 1990s two lines of argument had emerged from detailed fieldwork, often rooted in quantitative analysis, which rendered Agricultural Revolution a decidedly problematical concept.

First of all the specificity of the period 1760–1830 was placed under the microscope and found wanting. Eric Kerridge drew attention to the fact that a great deal of change had already occurred prior to 1760 despite an economic context broadly unfavourable to grain farmers: not only the routine reallocation of land to different purposes, but truly innovative developments in husbandry. Far from an Agricultural Revolution beginning in 1760 and reaching fulfilment in a matter of decades he considered that farmers ('gentleman farmers' and 'cultivating squires')¹⁴ rather than landlords worked a quiet transformation of agricultural practices and landscapes in the sixteenth and seventeenth centuries which was complete to all intents and purposes by 1720, if not earlier. It follows that Parliamentary enclosure played little part in the process, and neither did sown meadows of sainfoin or clover, or sophisticated rotations based on the Norfolk model, or new and improved technologies. According to Kerridge, the key innovations were entirely home-grown: the floating of meadows to stimulate early grass growth and what he labelled 'up and down' husbandry.¹⁵ that is to say the flexible alternation of tillage and grass in open fields. The phenomenon of Agricultural Enlightenment as we have defined it added nothing for the 'great spurt'¹⁶ in output had already occurred—between c.1540 and 1700. Thus by the time the Swedish traveller Pehr Kalm was moved to remark, in 1748, on the English practice of alternating ploughed fields and meadows an Agricultural Revolution of sorts had already happened.

Although Kerridge's reworking of England's early modern agrarian history served to alert researchers to the dangers of tunnel vision in supposing that substantial land reorganization could only proceed by Act of Parliament, or that innovation

¹³ *Annals of Agriculture*, 29 (1797), 522.

¹⁴ Kerridge, *The Farmers of Old England*, p. 132.

¹⁵ Kerridge, *The Agricultural Revolution*, p. 181.

¹⁶ Kerridge, *The Agricultural Revolution*, p. 336.

only happened in tandem with enclosure, he offered no quantitative support for his interpretation. Predictably, his refusal to accept that any kind of decisive breakthrough occurred from the middle of the eighteenth century, whether in terms of new crops or new techniques allowing significant increases in gross production or productivity to take place proved controversial in some quarters. Yet R. C. Allen implicitly acknowledges the merit of Kerridge's longer time span in formulating his own interpretation of England's Agricultural Revolution, even if he disputes the prevalence of 'up and down' husbandry. He links shifts in agriculture primarily to the expansion of the urban economy and attributes the doubling of farm output between the early sixteenth century and 1730 to a preliminary 'yeoman's revolution'¹⁷ which is supported with quantitative data drawn from farms in the South Midlands. By comparison the classic phase of Agricultural Revolution associated with Parliamentary enclosure witnessed only lacklustre growth in output and productivity per acre, although he does acknowledge that the rural economy powered ahead again from the time of the Napoleonic Wars. Nevertheless, in this early phase of demographic recovery the production of food was unable to keep up with population growth and England became a net importer of grain.¹⁸

In the face of these revisionist arguments upholders of the original English Agricultural Revolution thesis, the timing of which can draw some support from the impact of Agricultural Enlightenment on Europe's landowners and tenant farmers, responded either by diluting their interpretation somewhat or by dispensing with the notion altogether. Nevertheless, Mark Overton has argued strongly that a decisive breakthrough did indeed occur after 1750 or thereabouts, whilst not disputing the evidence of cumulative albeit non-revolutionary changes taking place from the middle of the seventeenth century onwards. New crops probably did not make much of an impact on yields until near the century's end but Parliamentary enclosure did, and both land and labour productivity were almost certainly on the rise.¹⁹ He points to the fact that in England after 1781 the rate of price increases started to ease notwithstanding the quite unprecedented pace of population growth. In other words farmers were somehow contriving to maximize their output in order to cater for the increased demand for foodstuffs.²⁰ The Agricultural Revolution is thus reinstated, if somewhat elongated to embrace the period c.1750–1850. After that date there is little disagreement among researchers that Europe's agriculture really did experience a productivity leap linked to the arrival of artificial fertilizers, labour-saving farm machinery, and farm restructuring.

One of the chief points at issue is the institutional impact of enclosure: in particular the enclosures achieved by private Acts of Parliament from mid-century onwards when nearly a quarter of the cultivated land of England was still under

¹⁷ Robert C. Allen, *Enclosure and the Yeoman*, part 1, also *The British Industrial Revolution in Global Perspective* (Cambridge, 2009), p. 58.

¹⁸ Robert C. Allen, 'Tracking the Agricultural Revolution in England', *Economic History Review*, 52:2 (1999), 217.

¹⁹ Bruce M. S. Campbell and Mark Overton (eds), *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity* (Manchester, 1991), p. 44.

²⁰ Mark Overton, *Agricultural Revolution in England: The Transformation of the Agrarian Economy, 1500–1850* (Cambridge, 1996), p. 69.

open-field management.²¹ Most historians accept that enclosure, whatever the motives of landlord petitioners, created conditions ripe for farm-gate innovation. Mark Overton cites a reporter of the Board of Agriculture who drew attention to the fact that turnips and clover were more frequently sown in the enclosed villages of Huntingdon and Rutland than in those which had retained common fields.²² R. C. Allen would not disagree with the observation.²³ Yet does this mean that land-use always changed when strips were consolidated into compact fields and that a consequential productivity gain per acre of land was always obtained? Landlord-driven enclosure may have had more to do with cost reduction, or else the ambition to secure a larger share of the profits accruing from farming to the detriment of tenants. Contemporary evidence highlights the fact that enclosure was usually followed by rent increases as though the land had suddenly become more productive—if only because the input of labour and draught animals had diminished. However, it is hard to disentangle the reality of such claims from the fact that they tended to emanate from sources which regarded enclosure as a ‘public good’ whatever the economic and social cost—Arthur Young in England for instance, or Nicolas-Louis François de Neufchâteau in France. In his *Voyages dans la sénatorerie de Dijon* (1806) which put pressure on France’s Imperial government to embark upon a programme of farmland consolidation (see chapter eight), François de Neufchâteau glossed the publications of England’s chief protagonists of enclosure (Arthur Young and William Marshall) with the observation, ‘according to these reports we can reckon that enclosure, generally speaking, doubles the rent yield of an open-field’.²⁴

The question of cereal yields is a vexed one. Output may simply have risen in the period of Agricultural Enlightenment because the surfaces under cultivation increased, whether by virtue of land reclamation or the systematic planting of the fallow. Sweden²⁵ provides an example of the former and the latter is evidenced in the case of England where the bare fallowing of land destined for arable use gradually declined from around 20 per cent in the 1690s to 12 per cent by the 1830s (4 per cent in 1871).²⁶ It is likely that acreages under wheat doubled between 1750 and the 1840s in consequence, although much new land which had rarely if ever borne crops was brought into cultivation here as well.²⁷ Increasing yields per unit of land was much harder to achieve in early modern Europe, though, and has proved even harder for researchers to measure in a convincing fashion. Rental, tithe, seed—yield and cadastral data have all been mined for this purpose, but with

²¹ Gregory Clark, ‘Commons Sense: Common Property Rights, Efficiency, and Institutional Change’, *The Journal of Economic History*, 58:1 (1998), 75.

²² Overton, *Agricultural Revolution in England*, p. 164.

²³ Allen, ‘Tracking the Agricultural Revolution’, 226.

²⁴ *Voyages agronomiques dans la sénatorerie de Dijon*, p. 123.

²⁵ Gadd, ‘The Agricultural Revolution in Sweden, 1700–1870’, in Myrdal and Morell (eds), *The Agrarian History of Sweden: 4000 BC to AD 2000*, p. 155.

²⁶ Overton, *Agricultural Revolution in England*, p. 99. Broadberry et al., *British Economic Growth*, p. 74 Table 2.10 propose slightly different figures. For a comparison of cropping ratios (a measurement of the intensity of land use) which demonstrates the huge gap between China and Europe, see Federico, *Feeding the World*, p. 95 and Table 6.1.

²⁷ Beckett, *The Agricultural Revolution*, p. 54.

mixed results.²⁸ Whilst agrarian historians of England have no qualms about accepting that cereal yields in all likelihood doubled between the Middle Ages and 1800, there has been much less agreement in this area for France, or for that matter Spain. On the evidence of official French crop-yield data published in 1840, Michel Morineau²⁹ concluded that, overall, no significant cereal productivity increase had occurred since the late Middle Ages save in respect of oats. It does seem to be the case that even in highly favoured grain-producing regions such as the Cambrésis yields only surpassed levels achieved in the 1320s in the third quarter of the eighteenth century.³⁰

France was slow to adopt land enclosure, often for highly specific institutional reasons. Moreover the French government's own agricultural statistics show, for what they are worth, that in 1840 around 20 per cent of the arable was still being fallowed each year.³¹ Yet it is fairly well established that the production of food-stuffs rose in volume terms across the eighteenth century—by between 25 and 40 per cent.³² Any claim that the country experienced a quickening of the rural economy in the period of Agricultural Enlightenment would have to rest on this basis, therefore. However, most historians consider that a full-blown Agricultural Revolution passed France by with structural reform slow to make progress even on the high-yielding cereal plains of the Île-de-France, the North East, and Alsace.

The agriculture of the southern Low Countries (Belgium) presented a picture of contrasts at the mid-century point. Eastern Flanders was already enclosed and fallow-free: it was reputed by Sir John Sinclair³³ to be the best-cultivated block of territory in the whole of Europe. However, the poorer land-locked regions of Namur, Ardennes, and Luxemburg offered considerable scope for growth, albeit from a very low base. These were the regions that made the running in the early nineteenth century—thanks largely to land clearance and the widespread planting of the potato as a field crop. Even so, cereal and potato production initially failed to keep up with population growth.³⁴ Economic tensions within the newly established Kingdom of the Netherlands (1814) compounded the difficulties of post-war agriculture as we have already noted and left rather unclear the economic role that farmers were now expected to play. Dutch cultivators, like their Belgian counterparts, embraced a very broad spectrum with low productivity open-field

²⁸ For a recent attempt to employ cadastral documentation for this purpose, see Carlos Santiago-Caballero, 'Provincial Grain Yields in Spain, 1750–2009', *Working Papers in Economic History*, (May 2012), Universidad Carlos III de Madrid, www.uc3m.es (accessed 19 January 2015); Carlos Santiago-Caballero, 'Trapped by Nature: Provincial Grain Yields in Spain in the Mid-18th Century', *Revista de Historia Económica/Journal of Iberian and Latin American Economic History* (January 2015), 1–28.

²⁹ Michel Morineau, *Les Faux-semblants d'un démarrage économique: agriculture et démographie en France au XVIII^e siècle* (Cahier des Annales 30) (Paris, 1971), appendix 1.

³⁰ Béaur, *Histoire agraire de la France au XVIII^e siècle*, p. 165.

³¹ Chevet, *La Terre et les paysans en France et en Grande-Bretagne*, ii, p. 38.

³² Béaur, *Histoire agraire de la France au XVIII^e siècle*, p. 135.

³³ *The Correspondence of the Right Honourable Sir John Sinclair*, ii, p. 149.

³⁴ Martine Goossens, *The Economic Development of Belgian Agriculture: A Regional Perspective, 1812–1846* (Brussels, 1992), pp. 12, 65–8, 166, 183, 313, 315–17; see also Erik Buyst, 'Estimates of Economic Growth in the Southern Low Countries / Belgium c.1770 – 1846', <http://dev3.cepr.org> (accessed 20 May 2014).

agriculture still being practised in the north-eastern interior while the coastal provinces had long ago pioneered forms of intensive, market-oriented husbandry. Zealand farmers, in particular, were admired for their immaculate weed-free fields. Already by the end of the sixteenth century they had obtained wheat yields that would not be surpassed for another two hundred and fifty years.³⁵

The reclamation of land (from pasture, heath, bog, and forest margins) is what powered Sweden's enclosure movement. In fact Sweden provides what is probably the best-documented example of how enclosure could lift both output *and* productivity. By and large this was an institutional process inasmuch as the towns were still too small to exert much of a market 'pull'. According to Patrick Svensson enclosed farms managed to lift production by an average of 12 per cent compared with unenclosed holdings, all other factors being equal. This finding is computed from a database relating to the agriculture of the southern province of Scania which includes nearly 33,000 production estimates derived from over 1,700 farms.³⁶ It is correlated to the *enskifte* reform, or radical enclosure legislation of 1803–07. The most efficient farmers turned out to be the larger freeholders who were in possession of secure property rights and for whom the eradication of the three-field system in favour of grouped holdings offered considerable scope for cropping innovation. The sharp increase in grain production which resulted stemmed mainly from a switch of meadowland to arable. In the parish of Hög situated in one of the most fertile districts of Scania, fallowing dropped sharply after the enclosure of village fields, while the acreage put under cereals increased from 74 per cent in 1804 to 87 per cent by 1828.³⁷ By this date Sweden had become a net exporter of cereals.

In Sweden as in Denmark the State took charge of the business of agrarian reform and pursued its objectives unswervingly. Yet even in countries such as France where political considerations often pushed country dwellers in different and sometimes contradictory directions broadly 'institutional' developments could have a local impact on agricultural productivity. The decision taken by the France's new legislators in 1789 to outlaw exclusive hunting rights transformed open-field agriculture in the vicinity of the royal game reserves and parks on the outskirts of Versailles. After killing all the game, cultivators proceeded to cut back by a fifth the seed corn used in the autumn and spring sowings.³⁸ In this instance thick sowing had offered some compensation for pest predation. On the other hand, we know that enclosure suffered a number of setbacks in France in the years after 1789 as hungry consumers used crowd pressure to intimidate improving farmers and landowners. By 1795 *prairies artificielles* (sown meadows) in the Creuse and neighbouring departments had mostly been ploughed in.³⁹

³⁵ Bieleman, *Five Centuries of Farming*, p. 49.

³⁶ Patrick Svensson, 'Why Did Enclosures Matter in Scandinavia, when They Didn't in Britain?' (Unpublished paper presented to the Social Science History Association Meeting, Miami, 22–26 October 2008), pp. 1, 9. I am indebted to Professor Svensson for giving me access to this paper.

³⁷ Svensson, 'Why Did Enclosures Matter in Scandinavia, when They Didn't in Britain?' p. 13.

³⁸ *Annals of Agriculture*, 13 (1790), 537.

³⁹ Jean-Baptiste Rougier-Labergerie, *Traité d'agriculture pratique ou annuaire des cultivateurs du département de la Creuse et pays circonvoisins [...]* (Paris, an III [1795]), pp. 336–40.

BIG VERSUS SMALL

The propaganda offensive waged across Europe in support of enclosure had as its pendant a debate about the optimum size of farms. Large farms held freehold or on long and renewable leases were an article of faith for Arthur Young and many other economic *Aufklärer*. Agricultural Enlightenment, in their minds, necessarily passed by way of the well-capitalized farmer with untrammelled access to the land who was enabled to achieve higher yields. 'The magic of PROPERTY turns sand to gold'⁴⁰ exclaimed Young when he unexpectedly came across neatly enclosed fields whilst trudging through sand dunes near Dunkirk during his second tour of France.

Yet property or secure tenancy was only the first step. In much of central and eastern Europe freehold property right was an alien concept as we saw in chapter two. Individualized tenure, whether hereditary or freehold, had to be established in law before the question of the ideal size of holdings could be addressed. France, as many a traveller would observe was a land characterized by *petite culture*: there were probably 4 million small owner-exploiters before the Revolution and by 1825 their number had risen by around a third to 6.5 million. By 1850 small and 'microscopic' owner-exploiters were tilling around 8 million hectares of arable and medium-sized owner-exploiters a further 13 million.⁴¹ Only in the west of Ireland and in north-western Spain (Galicia) in the early decades of the nineteenth century do we find a situation in any way comparable. In England, by contrast, the fragmentation of landed estates had been prevented by entail laws. Small and medium-sized farmers were a dwindling species: they probably owned about a third of crop-bearing land in the late seventeenth century, but not much more than 10 or 12 per cent a century or so later.⁴² The scale of farms increased as a result, although smallholdings were by no means completely eradicated even by the end of the nineteenth century.

In Scotland there was scarcely any peasant proprietorship as we shall see: only 2.3 per cent of adult males owned land in 1770 compared with perhaps 12 per cent in England and Wales (1798).⁴³ Ireland's agricultural economy was overwhelmingly peopled with tenant farmers of various descriptions as well, but two-thirds of Belgian farmland was in the hands of owner-exploiters by the early nineteenth century.⁴⁴ In Sweden successive waves of enclosure legislation completely altered not only the landscape (see chapter eight), but also the ownership structure. Many Crown and landlord estates were sold off as freeholds, with the result that by the middle of the nineteenth century 'approximately 60 per cent of Swedish farm land tax units were owned by peasant farmers'.⁴⁵ In other words the

⁴⁰ Arthur Young's *Travels in France*, 7 November 1787.

⁴¹ Béaur, *Histoire agraire de la France au XVIIIe siècle*, p. 34; *Des charges de l'agriculture dans les différents pays de l'Europe* par Maurice Block (Paris, 1851), p. 48.

⁴² Beckett, *The Agricultural Revolution*, p. 47.

⁴³ Neil Davidson, 'The Scottish Path to Capitalist Agriculture 2: The Capitalist Offensive (1747–1815)', *Journal of Agrarian Change*, 4:4 (2004), 438.

⁴⁴ Peter Solar and Martine Goossens, 'Agricultural Productivity in Belgium and Ireland in the Early Nineteenth Century', in Campbell and Overton, (eds), *Land, Labour and Livestock*, p. 381.

⁴⁵ Gadd, 'The Agricultural Revolution in Sweden, 1700–1870', in Myrdal and Morell (eds), *The Agrarian History of Sweden*, p. 135.

share of land owned as well as worked by ordinary farmers had more or less doubled since 1700.

From the third quarter of the eighteenth century it is apparent that policymakers in many parts of Europe were beginning to ask themselves questions about the size of farms. The issue was debated in England, France, and Scandinavia, in Scotland, Lombardy, and Naples, in Spain and in the German territories (Prussia, Austria, and some of the south German principalities). Were small farms more advantageous to the State than large ones? The answers given depended on what pundits and policymakers were seeking to achieve: reinvigoration of the rural economy, population growth, social transformation, or all three objectives rolled into one. British commentators seriously doubted whether the proliferation of smallholdings was conducive to Agricultural Enlightenment. They took a broadly capitalist view of agricultural improvement which emphasized the mobilization and efficient use of resources in farming and the exercise of close control over labour and other cultivation costs. The population question was not a pertinent issue; nor did anyone pause to reflect on the social benefits of anchoring the poor to the soil—at least not before the onset of the food shortages and civil discontents of the late 1790s and early 1800s. Arthur Young famously defended the big-farm approach to agriculture, although he did make an attempt to determine the effects of scale on productivity and would alter his thinking later on in life. The agricultural writer William Marshall's views were little different.

This could present a problem when the conventional wisdom was challenged by evidence of apparently efficient, high-yield crop production achieved on diminutive plots of not particularly fertile land. In 1790 Paolo Balsamo professor of agriculture at the University of Palermo, who was a long-standing intellectual companion of Young, reported on his trip through inland Flanders. While fully appreciative of the cropping achievements of Flemish *petite culture*, he insisted that they provided no model for England and queried whether a form of agriculture reliant on huge amounts of uncostered family labour could truly be described as efficient.⁴⁶ Whilst much of the land was being speedily recycled, the spectacle of up to five different crops growing simultaneously in a space of no more than four acres was not, in his judgement, a mark of good husbandry.

When travelling through the Spanish province of Catalonia with Maximilien de Lazowski in 1787 Arthur Young encountered many well-cultivated smallholdings, particularly on the approaches to Barcelona.⁴⁷ Yet at the same time he was struck by the rarity of large estates and the absence of a class of money-rent tenant farmers. Rationalizing the evidence of his eyes, he supposed that the plots hacked out of the dry and stony waste and planted with vines under-sown with corn must be owner-occupied. In fact, they were mostly sharecropped on the basis of emphyteutic or *rabassa morta* oral contracts which granted more or less perpetual use-rights to those who were prepared to engage their labour in the clearing of the land in

⁴⁶ *Annals of Agriculture*, 14 (1790), 355–8, 'Some Particulars relating to Flanders Husbandry by Signor Paolo Balsamo'.

⁴⁷ *Annals of Agriculture*, 8 (1787), 193–275.

return for a small share of the grape harvest. If it suited Young to interpret this particularly effective method of exploiting otherwise unproductive scrub as a vindication of industry linked to ownership, he was not alone for Catalans also seem to have regarded emphyteutic tenure as tantamount to freehold property. What Young failed to recognize though, or perhaps found it difficult to acknowledge, was that a system of irrigated agriculture based on diminutive plots of just one or two hectares was steadily transforming the rural economy of Catalonia and providing the capital wherewithal for manufacturing industry. Another English writer, the cleric and geologist Joseph Townsend whose travels in Spain were more extensive and much better informed, made no mistake on this score.⁴⁸

It is true that for many years historians shared this assumption that big farmers enjoyed economies of scale that were not available to smallholders and were therefore likely to behave in a more enterprising manner. But just as the fashion for asserting the superiority of enclosed over open-field agriculture has ebbed, so the claim that *petite culture* necessarily exerted a braking effect on the modernization process has been subjected to scrutiny. Quite apart from the well-documented cases of Flanders and the Dutch coastal provinces, there are several modern studies which formally contradict the notion that small farms were *ipso facto* less productive than large ones.⁴⁹ Crop yields do not correlate with size as Overton has pointed out⁵⁰ and there exists plentiful evidence of dynamic *petite culture* particularly in the specialized horticultural and fruit-growing sectors that flourished in the vicinity of towns across much of Europe. Whether small farmers were as innovative in the technological sense as their larger neighbours is another matter, though. Whatever was produced was generally produced by the expenditure of extraordinary amounts of labour in the context of a favourable price conjuncture.

The debate on optimal farm size in France began with the physiocrats. They envisioned the tenant farmer as a veritable agricultural entrepreneur who would bring capital to the land and make it fruitful. By implication this economic vision left little room for the smallholder, although the Marquis de Mirabeau clung to the belief that small-scale ownership still had a useful role to play. If it did not, the physiocrats must have imagined that by some sleight of hand the whole of France could be transformed into rolling prairies on the model of the open-field environment predominant around Paris and to the north and east. This illusion did not

⁴⁸ 'To the power retained by them [the landlords] of making emphyteutic contracts, has with reason been attributed the cultivation of such waste lands as are most susceptible to tillage, and the constant increase of population. Industry has been promoted, new families have been called into existence, and many, rescued from poverty and wretchedness, are now maintained in comfortable affluence', Joseph Townsend, *A Journey through Spain in the Years 1786 and 1791*. 3 vols. (London, 1792), iii, p. 332.

⁴⁹ For England see Robert C. Allen, *Enclosure and the Yeoman* (Oxford, 1992), chapters ten and eleven; for France Herment, *Les Fruits du partage: petits paysans du Bassin Parisien*; for Belgium Erik Thoen, 'A "Commercial Survival Economy" in Evolution. The Flemish Countryside and the Transition to Capitalism (Middle Ages–19th Century)', in Peter Hoppenbrouwers and Jan Luiten van Zanden (eds), *Peasants into Farmers? The Transformation of Rural Economy and Society in the Low Countries (Middle Ages–19th Century)* (Turnhout, 2001), pp. 102–57; for an overview Markus Cerman, 'Rural Economy and Society', in Peter H. Wilson (ed.) *A Companion to 18th Century Europe* (Oxford, 2008), pp. 47–65.

⁵⁰ Overton, *Agricultural Revolution in England*, p. 205.

long persist for the Administrative Committee on Agriculture set up in the aftermath of the 1785 drought, declared itself to be agnostic on the question of farm size.⁵¹ Although François de Neufchâteau would try to shift the debate in the direction of land consolidation and enclosure, the revolutionaries preferred to focus on the notion of the redemptive value of the small owner-occupied farm—as social bedrock for the new Republic. Once the merits of *petite culture* had been asserted in such stridently ideological terms it proved impossible any longer to approach the question solely from the point of view of agricultural economics. Instead, the fact that France had fewer big landowners who lived on their estates than did England or Scotland became a badge of honour. ‘Respectez la petite propriété’⁵² urged Napoleon’s former interior minister, the Comte de Chaptal, and do so for sound political, social, and moral reasons. By 1848 the small farm had even had democratic credentials attached to it. In that year of Europe-wide revolt and revolution, France was depicted by the deputy Jean-Eugène Dezeimeris as ‘the only country in the world where there exists nearly 5 million householders who are either ordinary owners of land or are chiefly occupied with the tilling of their own glebe’.⁵³

The cameralists also pondered the utility of the small farm. Quite modest holdings of 30 *Morgen* (between 15 and 22.5 acres) with secure tenure could be relied on to stimulate zeal and industry in the estimation of J. H. G von Justi. After all, ‘everyone knows that only personal interest motivates industriousness, and if this is lacking one can expect nothing other than sullen and bad work’.⁵⁴ However, he saw no reason to exempt such farms from partible inheritance custom which, in the Habsburg territories, caused alarm among officials. Fearful of unlimited divisibility, the Empress banned parcelling and in 1787 a law was introduced which stipulated that the eldest son should be considered the sole legal heir.⁵⁵ Prussia’s opportunity to debate farm size and the future shape and direction of the rural economy came in the midst of the trauma of defeat and devastation at the hands of the French in 1806–07. Proposals were drawn up to encourage the regrouping of small farms into larger units of between 4 and 10 *Hufen* (80–200 acres) in the belief that enhanced agricultural productivity would result. Ludwig von Vincke who, like Stein, had direct experience of England’s remarkable agrarian trajectory considered the persistence of very small owner-occupied farms to be a ‘burden to society’.⁵⁶

⁵¹ ‘La grande et la petite culture ont chacune leurs avantages, qui sont particulièrement relatifs à la disposition locale du pays et à la somme de capitaux que l’on peut employer’, Pigeonneau and de Foville, *L’Administration de l’Agriculture au Contrôle Général des Finances (1785–1787). Procès-verbaux et rapports*, p. 189.

⁵² Chaptal, *Chimie appliquée à l’agriculture*, i, p. xxxix.

⁵³ Annie Bleton-Ruget, ‘La Paysannerie en débat: autour du décret du 3 octobre 1848 sur l’enseignement agricole’, in Michel Boulet (ed.), *Les Enjeux de la formation des acteurs de l’agriculture, 1760–1945. Actes du colloque ENESAD, 19–21 janvier 1999* (Dijon, 2000), p. 48 n. 13.

⁵⁴ Werner Conze (ed.), *Quellen zur Geschichte der deutschen Bauernfreieung* (Göttingen, 1957), p. 44 cited in Ulrich Pfister, ‘Institutional Change and Agricultural Growth in Late Eighteenth and Nineteenth-Century Germany: a Survey’ (Unpublished paper presented to the workshop ‘Government and Agricultural Change in Comparative Perspective’, Lund University, Sweden, 16–17 October 2014).

⁵⁵ Link, *The Emancipation of the Austrian Peasant*, pp. 65–6, 126–7.

⁵⁶ Gray, *Prussia in Transition: Society and Politics under the Stein Reform Ministry of 1808*, p. 133.

All of the Prussian reformers wished to bring an end to collective agriculture (*Flurzwang*), but there was much less agreement on how to go about stimulating the growth of a yeoman peasantry. Extirpating small owners by government action might encourage landowners to resort to the 'clearance' solution: Stein and his officials were aware of what had transpired in the Highlands of Scotland and in Mecklenburg. On the other hand, there were real doubts about whether non-noble holdings of the desired optimal size could actually be created. In any case the debate on the small farm was re-visited as all German policy makers became increasingly preoccupied with the Social Question after 1814. Were they really as inefficient as the pioneer Reform-era Liberals had insisted? The Heidelberg professor of cameral science Karl Heinrich Rau and his colleague Robert von Mohl argued that they should be regarded as an integral part of the body politic on ethical grounds alone, albeit with a stipulation as to minimum parcel size.⁵⁷

In some parts of Europe it was the pressure on rural communities to relinquish their collectively owned and exploited pastures which precipitated the public discussion about farm size and modes of tenure. In Lombardy the Austrians had pursued a rather inconsistent policy on the subject of common land partition as we have seen. However, when in 1779 a policy of dismemberment finally received a firm go-ahead from Vienna in the name of agricultural productivity, the *Magistrato Camerale* in Milan added a rider to the decree. It instructed that commons closest to villages should be sub-divided so that small peasant farmers could compete in the marketplace for the land. Bidders intending to build a farmhouse were to be shown preference, particularly if they undertook to start cultivation of the land at the earliest opportunity.⁵⁸ In the southerly Kingdom of Naples reformers scarcely spoke with one voice when identifying pathways for economic growth either. Antonio Genovesi who occupied Europe's first chair in political economy at the University of Naples favoured a landlord-led Agricultural Revolution, but others looked to the small farmer as the main agent of progress. When the Jesuits were expelled from Sicily in 1767, it was decided that half of their landed assets should be divided among peasant households in small lots.⁵⁹ King Carlos III of Spain who had previously ruled Naples and Sicily would have been all too familiar with these debates. His influential adviser the Conde de Campomanes eulogized the small independent farmer and in his theoretical writings proposed the introduction to Spain of a version of the 'Agrarian Law'.⁶⁰

Much of the contemporary critique of the farming practices of big owners came from the agronomists whose feet were planted firmly on the ground, or else from those claiming direct experience of *petite culture*. It was pointed out, quite frequently by the 1800s and 1810s, that the owners of small fields lavished far more attention on them than did the owners of large who of course relied chiefly on tenants, croppers, or farm servants to do the day-to-day work. Personal industry

⁵⁷ Lindenfeld, *The Practical Imagination*, p. 127.

⁵⁸ Grab, 'Enlightened Absolutism and Commonlands Enclosure', 63.

⁵⁹ Girolamo Imbruglia, 'Enlightenment in 18th Century Naples', in Imbruglia (ed.), *Naples in the Eighteenth Century: The Birth and Death of a Nation-State*, p. 83.

⁶⁰ Niccolò Guasti, 'Campomanes' Civil Economy and the Emergence of the Public Sphere in Spanish *Ilustración*', in Astigarraga and Usoz (eds), *L'Économie politique et la sphère publique*, p. 240.

thus became an economic as well as a moral attribute. Yet this judgement did not sway the 'English' theorists of agrarian capitalism for whom the small farmer lay at the nexus of all those agricultural practices condemned by right-thinking persons. A report drawn up for the consideration of the London Board of Agriculture identified good middle-sized farms as having between 150 and 200 acres and small ones as having at most between 30 and 40 acres. The latter allegedly lacked capital and owed their continuing viability to the perpetuation of 'common fields' which were described as being 'naturally destined for small farms'.⁶¹ Smallholders were unable to manure their fields adequately, they did not follow best-practice rotations; they were unaware of the advantages of the division of labour, they practised mediocre husbandry and only ever achieved low yields ('poverty of produce').⁶² On the other hand it was conceded that they played a useful role in keeping the urban marketplace supplied with farmyard products, whereas big farmers could usually afford to hold back stocks of grain and speculate on rising prices.

Arthur Young now found himself condemned for some of the sweeping generalizations and dubious calculations enshrined in his earlier writings. Jane Marcet who frequently visited kith and kin in Switzerland objected strenuously to the suggestion that small farmers were economic laggards on the basis of her knowledge of the agriculture of the Vaud. In *Conversations on Political Economy*, a work which sought to introduce free-market ideas to ordinary members of the public, she rebuked Young for his labelling of small-scale property as the greatest of all sources of social misery but at the same time urged her pupil-interlocutor not to idealize the life of the poor peasant householder.⁶³ Young had repented somewhat by this date in any case. As evangelical religion began to take hold in old age he shifted his ground on the subject of enclosure, which he continued to support but with the caveat that compensatory measures be implemented to protect the interests of the rural poor. What he had in mind were smallholdings taken from the commons on which every labourer with a wife and children could grow nutritious potatoes and keep one or two cows.⁶⁴ Needless to say he was taken to task by readers of the *Annals of Agriculture* and others who accused him of apostasy.

DENMARK

Nowhere in Europe were the effects of agrarian reform more immediate and palpable than in Denmark. The transition experienced by Danes, over three-quarters of whom were country dwellers in 1760, has been described as a silent revolution carried out from above in the name of enlightened authoritarianism.⁶⁵ Many of the

⁶¹ *Communications to the Board of Agriculture*, vii, 38.

⁶² *Communications to the Board of Agriculture*, vii, 38.

⁶³ Jane H. Marcet, *Conversations on Political Economy; in which the Elements of that Science are familiarly explained* (London, 1816), pp. 230–40.

⁶⁴ Arthur Young, *The Question of Scarcity plainly stated, and Remedies considered* (London, 1800), p. 77.

⁶⁵ Barton, *Scandinavia in the Revolutionary Era*, p. 376; Thomas Munck, 'Absolute Monarchy in Later Eighteenth-Century Denmark: Centralised Reform, Public Expectations and the Copenhagen Press', *The Historical Journal*, 41:1 (1998), 214.

critical developments occurring in the dual monarchy of Denmark-Norway have already been identified in preceding chapters and it is now necessary to examine them more closely as part of the case-study evidence underpinning this investigation of Agricultural Enlightenment. Whilst our focus will be on the changes brought about within the rural economy between c.1780 and 1810, it should not be forgotten they were part and parcel of a much larger programme of State interventionism in society targeting education, poor relief, the penal law, religious minorities, banking, and the colonial slave trade. In the estimation of contemporaries whose opinions were inevitably coloured by knowledge of events in France these reforms ushered onto the stage the paradoxical spectacle of an absolute monarch taking steps to ensure that his subjects enjoyed 'all the blessings of freedom'.⁶⁶

On the face of the matter Denmark-Norway (the reforms chiefly applied to the former) was not promising territory for Agricultural Enlightenment, let alone Agricultural Revolution. The land was nearly all divided up into manorial estates owned either by the Crown or a few hundred private landlords. About 10 per cent was demesne property cultivated with the aid of compulsory labour and draught animals supplied by villagers and the remainder was leased to peasant households of which there were about 50,000 in the middle of the eighteenth century. In theory tenancy was for life provided the conditions attached to the farm holding were fulfilled. Manorial tenants cultivated open-fields under the watchful eye of the community although demesne land was not always well demarcated and could be mixed up with villagers' strips. The burden of manual labour owing to the seignior appears to have been increasing: in 1770, or thereabouts, two-thirds of tenant farmers in the islands and between 55 and 60 per cent in Jutland were liable to 'full service' (at least 200 days a year).⁶⁷ In addition, since 1733 all male peasants had been bound to the manor by restrictions preventing movement from their place of birth (the *stavnshåndet*). Although conditions such as these scarcely encouraged agricultural modernization, they did not altogether prevent it. Experimentation with legumes had begun in the 1770s, and many of the manor farms were switching to convertible husbandry or *Koppelwirtschaft* on the Holstein model which suggests, therefore, a degree of flexibility within an otherwise highly feudalized agriculture. The fact remained, however, that Denmark was deficient in useful knowledge and skill or 'know-how', deficient in natural resources, her industry was under-developed by continental standards and by the middle of the eighteenth century soil depletion and erosion had become serious issues in certain areas.

Historians have long acknowledged the decisive importance of the reform episode to the modern history of Denmark and have debated it at length.⁶⁸ Although enlightened landlordism certainly played a pathfinder role, building up a constituency prepared to support change and indicating the way ahead, it is generally agreed that the State played the role of prime mover. But was the 'problem' considered to

⁶⁶ Mary Wollstonecraft, *Letters Written during a Short Residence in Sweden, Norway and Denmark* (London, 1796), letter VII.

⁶⁷ Carol Gold, 'The Danish Reform Era, 1784–1800' (PhD dissertation, University of Wisconsin-Madison, 1975), p. 58.

⁶⁸ See H. Arnold Barton, *Essays on Scandinavian History* (Carbondale, IL, 2009), pp. 189–204.

be the quasi-enserfment of a previously free peasantry, or the concentration of land ownership in too few hands? Philosophical and humanitarian considerations were certainly starting to corrode old institutional structures elsewhere in Europe as we have noted, but equally States were resorting to reform measures for prosaic fiscal-military reasons; measures which inevitably posed a challenge to vested interests. In the case of Denmark it is possible to detect many factors at work: the reform agenda of a professional bureaucracy of liberal rationalists; the ambition to dissolve or at least to neutralize local power structures in the interests of unfettered monarchical absolutism; perhaps even a diversionary strategy to enable the landlord class to shed some of the more onerous responsibilities of manorialism whilst retrenching its wealth and authority on a new 'contractual' basis. We might ask, too, where the models and justifications for action, once it had been decided upon, came from. Were the reformers inspired by the physiocrats, the cameralists, or, as Dan Christensen has argued, a technologically fuelled vision of agricultural and industrial revolution which was taken as virtually a complete package from Great Britain and transferred directly to Denmark-Norway?⁶⁹

In the duchies (Schleswig was held by the Danish monarch as an independent principality and Holstein as a fiefdom of the Holy Roman Empire) it does seem that the influence of cameralism with its emphasis on the need to preserve small peasant producers was paramount. But divisions tended to open up among the reformers when they looked beyond the abolition of servility and contemplated the implications of a free and open market in land and, potentially, labour. Many estate owners felt that the pendant to the abolition of *stavnsbåndet* should be the right to dispose of their property as they saw fit. Yet the Danish agricultural reformer Christian Albrecht Fabricius advised that unlimited laissez-faire when applied to the land would necessarily bring into being a 'far more powerful aristocracy than the State has ever known in the past'⁷⁰ and one which would not be compatible with the interests of absolute monarchy. In practice, therefore, those of the reformers able to exert most control over the emancipation process, men like Count Christian Ditlev Reventlow or the Norwegian jurist Christian Colbjørnsen, endeavoured to keep the long-term welfare of peasant farmers in mind so that productive land did not pass out of their hands altogether. Needless to say, campaigners on both sides of the argument made free with the writings of French physiocrats and English partisans of enclosure.

A steady stream of inquiring Danes toured Britain from the 1760s and took back with them ideas (not to mention hand-tools, machinery, and skilled workers) which would come into their own when the reform era began in earnest. They included Christian Martfeldt who set up the Danish Society of Agriculture on his return to Copenhagen in 1768 and the young king, Christian VII, who arrived in London incognito in the same year. The Reventlow brothers (Christian Ditlev and Johan Ludvig) travelled extensively throughout Britain in 1769–70 stopping in,

⁶⁹ Dan Ch. Christensen, *Det Moderne Projekt: Teknik & Kultur i Danmark-Norge, 1750–(1814)–1850* (Copenhagen, 1996), part three and pp. 793–8, 800–8, 818.

⁷⁰ Barton, *Essays on Scandinavian History*, p. 198.

among other places, Birmingham in order to inspect Matthew Boulton's great manufactory at Soho. Count Andreas Peter Bernstorff would also spend over three years between 1755 and 1758 on a leisurely tour through Europe imbibing Enlightenment authors and garnering useful knowledge. All of these individuals would go on to hold high office or to play influential roles in the transformation of the Danish monarchy. The political economist Martfeldt entered the Board of Trade in 1773 and became a Councillor of State in 1779. The elder Reventlow embarked on a career in government service in 1773 and by 1784 headed the Exchequer, whereas his younger brother Johan Ludvig would be appointed to the Rural Reform Commission of 1786 on the strength of his reputation as an improving landlord and practising agronomist. As for Count Andreas Peter Bernstorff who belonged to a German–Danish dynasty of statesmen, he became Minister of Foreign Affairs in 1773 and Prime Minister of Denmark to all intents and purposes between 1784 and 1797.⁷¹ If we add the future financial administrator and state councillor Ernst von Schimmelmann who is not known to have travelled extensively, Denmark possessed by the 1780s a stable group of policymakers (and a pliable Crown Prince) which, as Thomas Munck⁷² remarks, was almost without example in Europe.

The trialling of agricultural reform on Crown estates has already been mentioned; also the early experiments in convertible husbandry of Count Rantzau-Ascheberg in Holstein which began in 1739. Despite increasing signs of the mental instability which would dog his reign, King Christian VII toyed with the idea of relaxing the servile regime—encouraged no doubt by his Swiss tutor Salomon Reverdil. It was regarded as the fundamental barrier to the social and economic improvement of the kingdom (already in 1757 a Land Commission had been put in place to investigate the conditions in which the peasantry lived). However, the real model for subsequent government policy was the estate reform pushed through between 1764 and 1767 by Andreas Peter Bernstorff on his uncle's properties near Copenhagen. Torkel Baden, the land steward in charge of this operation, wrote an instructive account of the enclosure and commutation process as we have seen, and of course the younger Bernstorff and his collaborators would be in an unrivalled position to implement their ideas more generally when they returned to power following the coup of 1784.

Although permissive measures targeting land held jointly by several villages and arable surfaces subject to the three-field tillage regime had been promulgated in 1769 and 1781 respectively, and a short-lived attempt had been made by Struensee in 1771 to tackle the problem of labour service, little was achieved on the ground before the 1790s. It is true that the Treasury started to allocate funds to meet the knock-on consequences of farm consolidation and enclosure (essentially the transportation of buildings out of the village) from 1781 and a Credit Office had been set up to provide loans—initially to landowners in order to help meet the costs of enclosure.

⁷¹ Lawrence J. Baack, 'State Service in the Eighteenth Century: The Bernstorffs in Hanover and Denmark', *The International History Review*, 1:3 (1979), 323–48.

⁷² Munck, 'Absolute Monarchy in Later Eighteenth-Century Denmark', 212–13.

However, the real turning-point came with the creation in 1786 of the Rural Reform Commission with Christian Ditlev Reventlow in the chair and Christian Colbjørnsen acting as secretary. Within two years this Commission had tabled proposals to terminate compulsory attachment to the soil (*stavnsbåndet*). Thereafter events moved swiftly. In a propagandist speech made in August 1788 on the occasion of the handing over (to Crown tenants) of the very first hereditary contracts, Reventlow unveiled the government's agrarian policy. It was motivated, he insisted, by considerations of well-being for the majority, not revenue raising in order to fill royal coffers: 'I see a time ahead in which the outlying fields will resemble the well-fertilised villages, the sour meadows and marshes will be changed into productive fields, useless scrub will be cleared away, useful forest and undergrowth carefully preserved, all harmful water carried off, all boulders used for permanent fences'.⁷³

In effect a massive programme of reorganization of the rural landscape was being announced (see pp. 208–13) and it would be accompanied by measures to convert peasants' manorial holdings into hereditary tenures and, in due course, freehold farms. Only the thorny question of the amount of labour service (*hoveri*) was left out of the account. Some landowners reacted with dismay and accused the Crown of spoliation. The *jacqueries* of 1789–90 were by now well known and a petition signed by about a hundred conservative landowners from Jutland who believed they were in no fit state to participate in agricultural modernization warned of the 'horrible examples'⁷⁴ of France. Yet despite the tense atmosphere in Copenhagen during the winter of 1790–91 and the none-too-reassuring news from revolutionary France, reforming ordinances were issued in quick succession. Strip consolidation and enclosure which almost inevitably involved the dismantling of both the agricultural community and the village habitat in its physical form began in earnest in 1792; government loans became available to householders so that they could buy the freehold of their farms; landlords were prevented or perhaps deterred from enlarging their demesnes by engrossing peasant tenures; minimum standards for field size and maximum distances between fields and farmsteads were decreed; fencing was rendered compulsory and some attempt was made to ensure that cottars were not left without a stake in the land, whether in their own interests or those of the manors which might otherwise be deprived of their labour.

The reformers wrestled long and hard with the compulsory labour service obligation that was attached to most tenancies. Abolition was considered to be essential if a productivity gain was to be achieved, yet the issue proved hugely difficult to resolve. Eventually agreement was reached, albeit at a high price, and by 1799 *hoveri* had been lifted from two-thirds of peasant farms. This left the tithe as a burden on production (not made commutable until 1810) and the fact that estate owners in Schleswig and Holstein had yet to agree to give up the servile system—something that was finally taking place as Thomas Malthus and his companions passed through the duchies in 1799. Andreas Peter Bernstorff, the chief minister, died in 1797 and the spate of reforms tailed off. Freedom of the press was curtailed

⁷³ Gold, 'The Danish Reform Era, 1784–1800', appendix D.

⁷⁴ Gold, 'The Danish Reform Era, 1784–1800', p. 42.

somewhat two years later and Denmark lost her commercial advantage as a neutral country in 1801 when she was gradually drawn into the orbit of war on the side of France. In 1807 she had little choice but to join the Continental System which immediately dislocated her economy.

Acute awareness of Denmark's technological backwardness in all but naval architecture resulted in sustained efforts to attract skilled manpower which were by no means confined to the rural economy. The Danish physiocrat Martin Hübner who joined the London Society of Arts in 1764 and helped Martfeldt set up a Society of Agriculture in Copenhagen drew attention to the labour productivity advantages of improved agricultural implements. In 1774 he calculated that if 25,000 high-performance ploughs such as were being used in England and low-land Scotland were imported into the kingdom, a saving of around 50,000 draught horses could be achieved. However, the country lacked the furnace skills that would allow a home-grown cast-iron smelting industry to develop as Dan Christensen has noted.⁷⁵ Ploughs with cast-iron mould boards were initially produced in Denmark by British migrant workers therefore. They in turn trained Danish-Norwegian apprentices with the result that by the turn of the century Denmark had started to make good its deficiency in this sector. By 1806 the old royal cannon foundry at Frederikvaert in Zealand was turning out threshing machines based on British templates with the aid of English workmen brought over from Robert Ransome's workshop in Ipswich. Paper-mill owner, I. C. Drewsen, acquired one of the machines so that he could harvest the rye from his estate and prepare it quickly for the export market at the point when grain prices touched their midsummer peak.⁷⁶

After 1807 and the conclusion of a formal alliance with Napoleonic France the purchase of freeholds ground to a halt. The next three decades were a difficult period for Danish agriculture as they would be for grain producers all over Europe. Even so, about 60 per cent of peasant farms had become freeholds by this date and the concomitant processes of land consolidation and enclosure had visibly altered the landscape (see chapter eight). The 1835 census recorded 41,695 owner-occupier households and 24,795 tenanted farms.⁷⁷ In fact the whole exercise amounted to an extraordinary example of the capacity of institutional power to alter durably agrarian infrastructures. But had the objectives first set out by Denmark's enlightened landowners and officials in the 1760s actually been achieved?

Contemporaries were in no doubt that agriculture had been rendered more innovative and productive. Their testimony is too extensive and too well documented to permit doubt on this score, even allowing for the tendency among propagandists of Agricultural Enlightenment to confuse wishful thinking with action on the ground. We may question Salomon Reverdil's confident assertion

⁷⁵ Christensen, 'Physiocracy—The Missing Link?' in Sundberg, Germundsson, and Hansen (eds), *Modernisation and Tradition*, pp. 86–7.

⁷⁶ Christensen, 'Physiocracy—The Missing Link?' pp. 86–7.

⁷⁷ See Kevin H. O'Rourke, 'Late 19th Century Denmark in an Irish Mirror: Land Tenure, Homogeneity and the Roots of Danish Success', <http://www.tcd.ie/Economics/staff/orourke/> (accessed 29 May 2014), p. 22.

that the prototype enclosure of J. H. E. Bernstorff's estate outside Copenhagen quadrupled stock levels in four years and increased yields perhaps by a factor of ten,⁷⁸ but the more forensic *post facto* observations of Gregers Begtrup, the Danish surveyor and savant, Thomas Bugge, and even Thomas Malthus point unmistakably in the direction of gross production and, in all probability, crop-yield increases. Reporting about twenty years after the tenure and land consolidation ordinances, Begtrup was struck above all by the changes which had occurred on enclosed peasant farms. The old three-field agriculture which allowed little room for the cultivation of fodder crops had been phased out and replaced with six- to eleven-year rotations containing much less fallow. This had facilitated the large-scale introduction of red clover and rye grass which had markedly improved the fertility of the soil.⁷⁹ According to the *Annals of Agriculture* which published in 1801 an extract from Thomas Bugge's *Travels* the rationalization of the landscape, in particular, had allowed much more land to be brought into regular cultivation, resulting in a countryside with a neat and prosperous appearance: 'whatever road you take through Denmark, you see commodious and well-built cottages, gardens, cultivated grounds, rich meadows, fine cattle grazing in clover fields'.⁸⁰ Thomas Malthus,⁸¹ an outsider whose observations also date from this period of high grain prices, was similarly impressed by the general well-being of Danish agriculture at this point, although as he crossed over to the islands he noted that open-field cultivation had by no means everywhere ceased.

Historians have been less sanguine, though. Research carried out to mark the centennial anniversary in 1888 of the abolition of adscription suggested that the reforms had made possible an average yield increase per unit of arable land of around 25 per cent (and a doubling of agricultural output) in the two decades following the establishment of the Rural Reform Commission.⁸² These are the figures most frequently encountered in the secondary literature. However, Christensen argues that the productivity bonus was not evenly distributed and was only secured by agricultural pioneers who were owners of big estates, or else by the 'gentlemen-farmers' heavily represented in the Royal Society of Agriculture. These were precisely the individuals who could afford to invest in improved agricultural technology. For peasant farmers 'productivity per person and per area unit was rather stable, in so far as the doubling of agricultural production took place by doubling the labour force on the same area as well'.⁸³ In other words the first way station of the Danish Agricultural Revolution was reached by means of a rise in

⁷⁸ *Struensee et la cour de Copenhague, 1760–1772 mémoires de Reverdil [...] précédés d'une courte notice sur l'auteur et suivis de lettres inédites* (Paris, 1858), pp. 91–2.

⁷⁹ Karen J. Friedmann, 'Fencing, Herding and Tethering in Denmark: From Open Field Agriculture to Enclosure', *Agricultural History*, 58 (1984), 595–6.

⁸⁰ *Annals of Agriculture*, 37 (1801), 132.

⁸¹ James, *The Travel Diaries of Thomas Robert Malthus*, pp. 44–5, 48–9, 52.

⁸² Friedmann, 'Fencing, Herding and Tethering in Denmark', 596.

⁸³ Christensen, 'Estimating Arable Production and Productivity in Danish Agriculture during the Age of Reform, 1750–1850', Bas J. P. van Bavel and Erik Thoen (eds), *Land Productivity and Agro-Systems in the North Sea Area (Middle Ages–20th Century): Elements for Comparison* (Turnhout, 1999), p. 182.

labour intensity, albeit one fostered by institutional arrangements that greatly increased the incentives to grow more crops and raise more animals. Yet even this scenario does not satisfy Thorkild Kjaergaard, who believes that the positive economic impact of the agrarian reforms of the 1780s and 1790s has been hugely overstated. The consolidation via freehold tenure and enclosure of small and medium-sized peasant farms led not 'to growth, progress, and the liberation of hitherto restrained forces',⁸⁴ but to agricultural stagnation in his view.

SCOTLAND

It is instructive to juxtapose the case of Denmark with that of Scotland: the only other country in Europe where multiple pressures for change resulted in a restructuring of large parts of the rural economy in just a few decades. In lowland Scotland, scholars now recognize, Agricultural Revolution occurred more or less in tandem with Agricultural Enlightenment. Tom Devine⁸⁵ evokes an agriculture in the grip of a series of transformative changes from the 1760s, a portrayal largely endorsed by Chris Smout,⁸⁶ whilst Neil Davidson goes further and labels the Scottish case 'one of the most spectacularly successful transitions to capitalist agriculture in the historical record'.⁸⁷ Accompanying this picture of dynamism and technological precocity is an acknowledgement that the ideas of the Scottish Enlightenment both fuelled and shaped the changes taking place.

Educated Scots were fully aware of the underdevelopment of their country at the time of the Union (1707) and for several decades beyond. The post-Renaissance 'world-wide farming web'⁸⁸ had passed Scotland by and there was little in the way of agronomic literature to draw upon before the 1750s and little to stimulate endogenous change save perhaps for the activities of a handful of landowners on their home farms. Urban demand was more or less static in the first half of the eighteenth century and agricultural commodity prices languished. The old Scottish Parliament had provided a legislative framework, in 1695, to dismantle the more regressive features of traditional collective agriculture and to partition common land, but implementation appears to have been slow and timid prior to the 1760s and 1770s.

As we have noted most farmers were the tenants of around 7,500 landlords, and most continued to pay rent in kind. It is an exaggeration to claim as did Lord Ernle⁸⁹ that the Scottish method of raising food crops had remained unaltered since the battle of Bannockburn (1314), nevertheless the runrig system prevailed widely both in the Lowlands and in the Highlands and could be found still in the

⁸⁴ Kjaergaard, *The Danish Revolution*, p. 249.

⁸⁵ Devine, *The Transformation of Rural Scotland*, pp. 42, 165.

⁸⁶ Smout, 'A New Look at the Scottish Improvers', 134.

⁸⁷ Davidson, 'The Scottish Path to Capitalist Agriculture', 227.

⁸⁸ Thirsk, 'The World Wide Farming Web, 1500–1800', in Broad (ed.), *A Common Agricultural Heritage? Revising French and British Rural Divergence*, pp. 13–22; also Smout, 'A New Look at the Scottish Improvers', p. 126.

⁸⁹ Ernle, *English Farming Past and Present*, p. 160.

1780s. This 'mixed property' mode of land tenure presupposed several co-habiting families grouped in a 'ferm town' who would share the rent burden and at intervals carry out a reallocation of the open-field strips or 'rigs' by lot. The periodic redistribution of strips had often ceased by the middle of the century, yet the tenants remained bound together by the lease and quite unable to alter the basic pattern of agriculture on their scattered holdings. Under this system the arable was divided into croft or infield land situated close to the farmstead which was repeatedly cropped using whatever dung was available and the outfield territory which never received manure and was abandoned to long fallows after three or four successive plantings of oats. Beyond the outfield lay the 'commonities', that is to say the permanent grazing. The Earl of Dundonald explained this form of husbandry to his readers as follows, 'the infield, in the treatment it received, and in its quality, resembles the inclosed cultivated lands in England; while the outfield was similar to the unenclosed common fields in this country'.⁹⁰ But this was at the very end of the century by which time improvement had mostly converted the rigs into compact and exclusive possessions. Indeed, by this date the pace of change had become so rapid that the disparity between Scottish agriculture in the most favoured eastern lowland areas and agriculture across the border had largely ceased to exist.

In contrast to Denmark, this transformation was piloted by landlords rather than by government. Moreover it was facilitated by a sharp upturn in demand for foodstuffs from domestic urban markets and by ready access to private investment capital—factors which the Danish modernizers could scarcely count upon. In both countries, on the other hand, the useful knowledge component of the Enlightenment played a significant role: in providing a general framework for improvement and an incentive to embark on structural reform. Of course the State was not entirely absent from the arena of Agricultural Enlightenment and Agricultural Revolution in Scotland, but it remained in the background for the most part. Major infrastructure projects became feasible following the passing of the Turnpike Act in 1751. By 1784 the country had been equipped with over 1,000 miles of highways which enabled the economic transportation of lime and coal among other things over ever greater distances. Also strict entail was eased by an Act of 1770 following pressure from a group of lowland landowners. These men had links with Lord Kames (Henry Home) who had been put in charge of property seized by the authorities after the abortive 1745 uprising; it was on such estates that the improvement agenda was pioneered.

Lord Kames and his protégé Andrew Wight, who would go on to chronicle the activities of over a thousand improvers, can be counted among the devotees of 'rational' agriculture. In the Scottish context this presupposed the abolition of runrig, multiple tenancy, and the payment of rents in kind. It prescribed the draining, enclosing, liming or marling, and manuring of the land; the adaptation of rotations to accommodate sown grasses and turnips; trials of hardier strains of oats; and intensive stock-raising involving imported breeds of sheep and cattle. Although

⁹⁰ Dundonald, *A Treatise Shewing the Intimate Connection that Subsists between Agriculture and Chemistry*, p. 172.

the really decisive period of change only gathered momentum in the aftermath of the Seven Years' War, the task of rationalizing Scottish agriculture was not without setbacks. There were moments when the improvers flinched at the scale of the project, particularly when commodity prices sagged in the mid 1770s and early 1780s and tenants got into difficulty with their rents. Whilst the intellectual argument for Agricultural Enlightenment never ceased to gain in cogency, it was the sharp rise in farm-gate prices during the Napoleonic Wars which really consolidated the success of the enterprise.

Landlord activism was certainly the hallmark of Scotland's Agricultural Revolution, but the transition would not have occurred without the backing of a class of compliant tenant farmers who were enterprising in outlook, experimentally minded, and increasingly literate as we have already had occasion to note. They, too, rose to the challenge of what Robert Burns described as the 'new husbandry'.⁹¹ In Scotland, especially, agricultural improvement became something of a mission. It was not rooted solely in a calculation of benefits set against costs as some of the older secondary literature appears to suggest.⁹² Land magnates such as the Duke of Gordon, Lord Hailes, Lord Monboddo, or Archibald Hamilton of Dalziel were committed to improvement as an ideology of utility for its own sake. In fact Lord Monboddo set about the modernizing of his Kincardineshire tenancies despite his financial self-interest and is reported never to have made a clear profit of more than £300 per annum as a landlord in consequence.⁹³ Indeed, as economic fair weather conditions returned in the early 1780s one contemporary observer noted that in Fife properties were being traded at double or even treble their assessed value owing to a conviction which amounted to a faith in their improvability: 'it is astonishing to what length people will go in these speculative purchases, and to what extent they will carry out these expectations on the supposed Capability and Effect of Improvements. Yet these estates are all in a state of nature: no houses, no inclosures, no wood, no lime or coal and everything to do upon them'.⁹⁴

Brian Bonnyman⁹⁵ has managed to reconstruct the management strategies of Henry Campbell Scott the third Duke of Buccleuch, or to be precise those of his long-serving factor William Keir, and again we find a public-spirited zeal for agrarian renewal much in evidence. It was certainly politic to view improvement through a wide-angle lens, for start-up costs were high and prospects of pecuniary payback small in the short term as the French chemist Lavoisier (acting in his capacity as an enlightened landowner) ruefully observed.⁹⁶ Yet in 1779 the Duke started to demur

⁹¹ Leask, *Robert Burns and Pastoral: Poetry and Improvement in Late Eighteenth-Century Scotland*, p. 23.

⁹² See Ian H. Adams, 'The Agents of Agricultural Change', in Parry and Slater (eds), *The Making of the Scottish Countryside*, p. 170; also R. H. Campbell, 'The Enlightenment and the Economy', in R. H. Campbell and Andrew S. Skinner (eds), *The Origins and Nature of the Scottish Enlightenment* (Edinburgh, 1982), pp. 112–13, 22–3.

⁹³ Richard H. Fowler, *Robert Burns* (London, 1988), p. 137.

⁹⁴ Devine, *The Transformation of Rural Scotland*, p. 61.

⁹⁵ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment'.

⁹⁶ See Antoine Lavoisier, *De la richesse territoriale du royaume de France. Texte et documents présentés par Jean-Claude Perrot* (Paris, 1988), p. 213.

at the inexorable rise in estate improvement expenditures (nearly £5,000 over the previous two years) and requested some abatement. This would bring them down to an average of about £1,000 per annum. The main outlay for landowners consisted of the erection of farm buildings, for tenants were expected to finance enclosure and pasture improvements from their own profit margins. Nevertheless, the Duke of Buccleuch also countenanced the spending of large sums on infrastructure projects, notably the Carlisle–Edinburgh turnpike and on excavations for marl and coal.

Improving leases were a key weapon in the war on agricultural backwardness in Scotland. William Keir showed himself to be less interested in securing the very highest rent for the duke's farms than in securing a commitment to modernize. The new policy began in 1767 when leases of the estate of Eckford (Roxburghshire) were publicly advertised with the condition of enclosure attached and the incentive of a landlord commitment to furnish the hawthorn hedging and any new buildings that might be required. All were in runrig, that is to say the infield, and all but two had been held in multiple tenure. Even so, two continuing tenants gave up their holdings after six months. Subsequent applications for these vacant holdings would be turned down by Keir on the ground that the prospective tenants 'would not agree to such conditions as I thought was absolutely necessary for the improvement of the ground', notably enclosure and the addition of marl to the soil.⁹⁷ Such leases had become commonplace by the 1790s, though; at least this appears to be the case in the counties which Devine investigated in the course of his researches (Angus, Fife, Ayr, and Lanark).⁹⁸ By 1810 Keir's efforts to obtain the improvement of the duke's upland sheep farms were beginning to bear fruit, too. A skilled 'drainer and flooder'⁹⁹ was brought in at the landlord's expense and on the Eskdale estate (sixty farms) only ten still showed no signs of improvement since the let of 1802.

It is probable if not certain that both Buccleuch and his estate manager Keir were influenced, whether directly or indirectly, by Adam Smith whose *Wealth of Nations* resembled an agronomist treatise in part. Smith had been hired as travelling companion and tutor to the young nobleman for his European tour and they spent nearly three years together. After his majority in 1767 the duke started to move among the luminaries of the Scottish Enlightenment and would become the first president of the Royal Society of Edinburgh. He remained on good terms with Smith who was a regular guest at Dalkeith House. Did the political economist have a hand in the ambitious decision of 1767 to go for a general 're-setting' or re-leasing of all the Scottish estate farms on longer terms? It seems very likely. Smith's scenario for economic development granted pride of place to agricultural improvement spearheaded by smaller owner-exploiter farmers, or else tenants incentivized by the security of long leases. He would eventually come to the conclusion that even a lease of twenty-nine years was too short.

The agricultural economy, according to Smith, should be recognized as having a key role to play in the 'natural progress of opulence' (Book III, *Wealth of Nations*)

⁹⁷ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', p. 129.

⁹⁸ Devine, *The Transformation of Rural Scotland*, pp. 43–4.

⁹⁹ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', pp. 180–2.

inasmuch as its allocation of labour to productive uses added considerably to the wealth of States—more so than did manufacturing and overseas commerce. Therefore Buccleuch's self-interest in seeing to the improvement of his properties chimed in with the national interest. Smith's mentoring of the duke is hard to pin down precisely as Bonnyman acknowledges, yet it does seem clear that he had a direct influence on the factor William Keir's rather theoretical view of improvement.¹⁰⁰ Keir's understanding of the optimum rent that could be achieved, notably the distinction he drew between the 'market' value and 'real' value of farm holdings borrowed from Smith's argument about the real value or price of commodities (Book I, *Wealth of Nations*) and there can be little doubt either about the filiation between Smith and Keir's notions of emulation and enlightened self-interest as forces to be enlisted in the service of improvement. However, Keir was plainly reluctant to reduce the business of letting farms solely to matters of self-interest whether enlightened or not; in other words to place the relationship between the duke and his tenants on a purely commercial base.

The case of the third Duke of Buccleuch and Adam Smith is unusual if only for the eminence of the intellectual source underpinning this instance of agrarian renewal. But links between the Enlightenment and Scotland's late eighteenth-century Agricultural Revolution exist aplenty. We know that Sir John Sinclair practised what he preached on his Caithness estates. He eradicated runrig, promoted enclosure, specified the rotations his tenants were expected to follow and imported experts in fen husbandry from England. Convinced like so many educated men of his generation of the power of the printed word, he diffused among the 900 or so crofter families information sheets distilling practical knowledge extracted from the farmers of the Moray Firth, adding a system of premiums in order to stimulate the social mechanism of emulation.¹⁰¹ In fact the literature of Agricultural Enlightenment in Scotland grew steadily more functional and prescriptive as the century advanced. This trend has already been noted in connection with the successive editions of Adam Dickson's *Treatise of Agriculture*. Sinclair was nothing if not an activist, hands-on farmer and he soon turned his gaze to the potential of the Highlands as sheep pastures, recommending that traditional breeds be replaced with white-faced Teviotdale specimens from the Borders. To this end he called landowners together to found, in 1790, a Society for the Improvement of British Wool.

Scotland seems to have spawned more agricultural improvement societies per head of population than anywhere else in Europe. By the 1780s their main role amounted to the dissemination and perhaps also the policing of good farming practice rather than the instigation of structural change which by this date was already well under way. They could be found even in quite small localities. This suggests that the improvement constituency had expanded to embrace the rural middle class and was no longer confined to the literati, the landowners and their more commercially minded tenants. The Middleton Farming Society expected its

¹⁰⁰ See the discussion in Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', chapter seven.

¹⁰¹ Handley, *The Agricultural Revolution in Scotland*, p. 94 and note 122.

members to attend meetings either with a pre-prepared script, or a readiness to discourse at large on an aspect of husbandry. That of Strathallan instituted a system of inspection and reporting which focused on members' own farms.¹⁰² Such bodies could scarcely afford to incentivize local farmers and rural artisans via the competitive award of premiums, but where such stimuli existed there is evidence to indicate that they did play a role in encouraging experimentation and innovatory practices. The Dalkeith Farming Club offered a very large premium of £500 to anyone who could construct a two-horse reaping machine capable of cutting two (Scots) acres of grain in five hours. James Smith of Deanston presented himself to the Club repeatedly between 1812 and 1814 with ever more enhanced versions of his device and was rewarded appropriately. He was still experimenting in 1835 when the most convincing demonstration of his technology took place on the occasion of the Highland Society's agricultural show in Ayr.¹⁰³

In spite of all this evidence of 'progress', it is far from certain that land and labour productivity rose as a consequence. Enclosure was in some ways easier to achieve in Scotland than in England since no legislation was required—merely a procedure conducted in the presence of the sheriff. But enclosure was not regarded as the panacea and improvers seem often to have concentrated as much on fallowing practices, new crops, and more resistant, higher-yielding strains of cereals. Putting thorn hedges around pre-existing rigs did not *ipso facto* enhance land use. On the other hand the planting of a hedge was a statement of intent to embrace change and to make use of the new knowledge and new technologies which were now available, notwithstanding their short-term drawbacks and inconveniences.

It was the recovery and expansion of the market which ensured the success of Agricultural Revolution in Scotland. Whilst yields undoubtedly rose significantly over the longer term, they did so from a very low base. Tom Devine¹⁰⁴ reckons that by 1800 they had increased threefold when compared with seventeenth-century averages in Angus and Lanarkshire, and twofold in Fife and Ayrshire. But gross land rent fairly exploded at the end of the century thanks to the boom of the war years: from an estimated £2m plus in 1795 to over £5.25m in 1815.¹⁰⁵ This was the context in which the pundits of Fife opined (in the 1790s) that enclosure could be achieved for £2 per acre and that the investment would pay for itself in four years.¹⁰⁶

Of course Denmark benefited from this favourable conjuncture as well, or at least she did whilst a neutral State. However, Scottish landowners and tenant farmers generally had rapidly expanding urban markets close to hand, together with highways and canals along which to transport their produce. The seemingly insatiable demand for bread grains, horticultural products, and fat-stock enabled Scottish agriculture to accelerate quite swiftly in the direction of specialization and intensive land use. Dairying and fruit-farming developed precociously in order to supply consumers in the industrial centres of Ayrshire, Renfrewshire, and

¹⁰² Boud, 'Scottish Agricultural Improvement Societies', 80, 82.

¹⁰³ Handley, *The Agricultural Revolution in Scotland*, pp. 70–80.

¹⁰⁴ Devine, *The Transformation of Rural Scotland*, pp. 56–7.

¹⁰⁵ Handley, *The Agricultural Revolution in Scotland*, p. 242.

¹⁰⁶ Devine, *The Transformation of Rural Scotland*, p. 46.

Clydesdale. Specialized cattle-raising concentrated in southern Lanarkshire and the highlands of Angus. Farmers planted fodder crops in the vicinity of the capital, whilst kitchen gardeners grew soft fruit and vegetables with the aid of urban manure scooped from the streets and privies of Edinburgh and Leith.

Nearly all stories of rapid and apparently successful agricultural development enshrine a more negative narrative and our two case studies are no exception in this regard. Denmark's bureaucratic reformers who did not envision themselves first and foremost as landlords, worried about the fate of those at the bottom of the social scale: the rural labourers and the cottars or cottagers. Everywhere in Europe the landless or semi-landless relied for their livelihood on the persistence of the commons and the collective rights that went hand-in-hand with open-field agriculture. Even though measures were introduced by the Danish monarchy in the 1790s to help rural workers build cottages with plots of land attached if only to ensure a steady supply of paid labour to the manors, it can be argued that the reforms stratified the peasantry and thereby stored up problems for the future. By the late nineteenth century cottagers without land—in effect a rural proletariat—had become a problem requiring urgent action by government. Yet historians were curiously slow to recognize that the first, fabled stage of Denmark's Agricultural Revolution had created a class of losers as well as winners. Not until Fridlev Skrubbeltrang's work on the cottagers of Zealand was published in 1940 was this dimension highlighted.¹⁰⁷

The fate of the settled population of the Scottish Highlands is well known of course. From the 1780s hereditary landowners spearheaded the drive to introduce sheep-raising in the place of mixed agriculture which entailed a considerable and sometimes forcible displacement of farming families as well as the construction of new settlements on or near to the coasts. Nothing equivalent happened in the Lowlands as we have seen. Indeed, the new husbandry in the Lowlands appears to have increased the demand for labour in some parishes, creating opportunities for wage-earners and a rationale for accommodating or establishing cottager holdings within the newly enclosed and improved landscapes. However, the objective of restructuring class relationships in the countryside was not absent from the minds of Scottish landowners or their factors and there were casualties along the way. Partition of the commons and the eagerness of owners to synchronize lease re-sets so that farm holdings could be modified or consolidated threw livelihoods into jeopardy. Many a small farmer in hillier and more marginal zones such as the Sidlaws or the Ochils succumbed in consequence. They ended up either seeking work as casual labourers on improved farms or moving to the towns.¹⁰⁸ Yet if cottager households with precarious access to land declined overall, it seems that the small tenant farmers did rather better and managed to find a place within Scotland's revitalized agrarian structures.

¹⁰⁷ See Claus Bjørn, 'The Study of the Agrarian History of Denmark: A Brief Introduction to the Literature', *The Agricultural History Review*, 22:1 (1974), 50–3.

¹⁰⁸ Bruce P. Lenman, *Enlightenment and Change in Scotland, 1746–1832*, 2nd edn. (Edinburgh, 2009), p. 164.

7

The Science of Agriculture

The solid knowledge foundation upon which to build a rational system of husbandry was laid in the second half of the eighteenth century as we have seen. Agronomy was the first ‘science’ of agriculture to secure recognition and by the 1840s an alliance of the natural sciences with agriculture was being hailed as the way of the future in the popular press of many countries of Europe. In England the Royal Agricultural Society which had received its charter in 1840 adopted for a motto ‘Practice with Science’. Yet the route towards the scientification of agriculture only appears obvious and direct in hindsight. At the turn of the century it was far from clear how, and how far, practising agriculturists would accept the new experimentally tested bodies of knowledge and incorporate them into their day-to-day routines. German farmers of the 1840s and 1850s were not alone in dismissing what passed for agricultural science as ‘graue Theorie’¹ having little relevance to what actually went on in the fields and in the byres. The claim of agronomy to be a discipline possessing scientific credentials was hampered from the outset by this tension, and in the event the initiative passed largely to the chemists and to chemistry—the all-conquering science of the first half of the nineteenth century. The French academician René Réaumur was perhaps the first to have envisaged the construction of a ‘*chymie agricole*’² around 1730. In 1804 the apothecary Sigismund Friedrich Hermbstädt would launch a journal entitled *Archiv der Agrikulturchemie für denkende Landwirthe* (Archives of Agricultural Chemistry for Thinking Farmers) and it was at about this time that Sir Humphry Davy began his course of lectures on agricultural chemistry in London—at the behest of the Board of Agriculture.³

The perceived relevance of chemistry to the agricultural sector stemmed from the entwining of several currents of Enlightenment thought and practice: the search for ‘system’; the drive for ‘precision’; and the spate of remarkable discoveries of minerals, metals, and gases occurring in the 1770s and 1780s as a prototype analytical chemistry started to challenge more venerable traditions and modes of

¹ From Goethe’s *Faust*, ‘All theory, dear friend, is grey while life’s golden tree is green’, cited in Jonathan Harwood, *Technology’s Dilemma: Agricultural Colleges between Science and Practice in Germany, 1860–1934* (Berne, 2005), p. 30.

² André J. Bourde, *The Influence of England on the French Agronomes* (Cambridge, 1953), p. 168.

³ *Elements of Agricultural Chemistry in a Course of Lectures for the Board of Agriculture*. By Sir Humphry Davy (London, 1813).

investigation. It is likely that the alignment was favoured by late eighteenth-century political developments, too, for a putative chemistry of agriculture must have seemed like relatively safe territory on which to carry out research in the aftermath of the French Revolution. Enough has been said about the Europe-wide endeavour to formulate and actualize a 'rational' approach to agriculture. Despite the waning of the Enlightenment this aspiration remained undimmed: it simply moved out of the study and the reading cabinet and into the laboratory. The obsession with accurate measurement—of inputs and outputs in modern terms—was part and parcel of the ambition to mathematize Nature; in other words to establish irrefutable experimental 'facts' and thereby construct an economy of portable knowledge.⁴ Savants were joined in this activity by the bureaucrats of the interventionist State, the seemingly incorrigible variability of the 'agricultural arts' proving no deterrent to the enumerators and quantifiers. In 1786 Broussonet, secretary of the Paris Société Royale d'Agriculture urged that chemists be enlisted the better to understand plant nutrition; mechanics in order to devise more efficient farm-tools; naturalists to enhance stock-raising; and botanists to identify and select the most promising cultivars.⁵

CHEMISTRY

Chemistry formed but a part of an eclectic effort by savants to apply the discoveries of natural philosophy to agriculture. It also attracted dilettantes who thought nothing of switching their energies and enthusiasms from one area of investigation to another. 'I have been amusing myself with dipping into the theory of agriculture; and at every turn I find more philosophy in it than I am master of', remarked the eminent Scots advocate Lord Kames (Henry Home) in 1775 to the university-trained chemist Joseph Black.⁶ Of course, the category of what passed for chemical knowledge was still quite broad in the second half of the eighteenth century. It bracketed together minerals, heat, and the phenomenon of electricity for instance. Inquiry into the potential applications of electricity began around 1750 and was soon extended to plant life as savants both known, unknown and soon-to-be-known (Maimbray, Priestley, Ingenhousz, Volta, Bennet, the *abbés* Nollet, Bertholon, d'Ormoy, etc.) set out to discover whether electric 'fluid' might speed up germination, or promote green growth. Arthur Young carried reports on the results of this pioneering electro-horticultural research in the *Annals of Agriculture*.⁷

The Swedish mineralogist Johan Gottschalk Wallerius (Torbern Bergman's professorial predecessor at Uppsala University) appears to have been the first explicitly to juxtapose chemistry and agriculture—in the Latin title of the dissertation

⁴ Matthew Norton Wise (ed.), *The Values of Precision* (Princeton, NJ, 1995), pp. 3–7.

⁵ AN F¹⁰ 260 'Exposé des travaux de la Société royale d'agriculture par M. Broussonet, 1786'.

⁶ Charles W. J. Withers, 'William Cullen's Agricultural Lectures and Writings and the Development of Agricultural Science in Eighteenth-Century Scotland', *The Agricultural History Review*, 37:2 (1989), p. 156 note 73.

⁷ See *Annals of Agriculture*, 14 (1790) and 15 (1791).

prepared in 1761 by his pupil Count Gustavus Adolphus Gyllenborg.⁸ Nevertheless, the running in this area was made by Scottish natural philosophers and improvers in the main. In 1756 Francis Home informed readers of *The Principles of Agriculture and Vegetation* that a grasp of chemistry was a pre-requisite if the rules governing husbandry were to be properly understood and implemented. However, 'this science is but of late invention, and has not yet been cultivated with that regard for utility, and the improvement of trades and manufactures as it ought and might'. As yet, therefore, 'agriculture is hardly sensible of its dependence on it'.⁹ Home's book scarcely signalled a new era of agricultural science, though. It was written in response to a prize essay competition and was rooted in the traditional chemistry of the elements handed down from the Ancients.

Yet this situation started to change in the 1770s, notably with the publication of *Elements of Agriculture and Vegetation* by another Scots physician George Fordyce.¹⁰ His book mobilized for a wider audience the chemistry lectures he had been in the habit of delivering for a decade and more. It was up-to-date and drew readers' attentions to recent knowledge additions in areas such as soil analysis and plant physiology. However the work was scarcely an instruction manual for the practising farmer and provided little in the way of concrete scientific guidance for the would-be improver. Only with the Earl of Dundonald's book (*A Treatise Shewing the Intimate Connection that Subsists between Agriculture and Chemistry*) which appeared in 1795 when the Scottish Agricultural Enlightenment was running at full flood do we enter the realms of science attuned specifically to practice. According to Dundonald the relative backwardness of agriculture when compared to the rapid advances being made at that time in the manufacturing sector, derived from a want of knowledge of applied chemistry and more especially a proper understanding of the role and action of manures. 'Hitherto', he observed, 'agriculture has been considered immune to chemical reasoning', yet if the farmer were to adopt the procedures of analytical chemistry as fleshed out by the author, 'all his future attempts to improve the soil, [and] the success of his operations may no longer depend on guess-work, or on chance, but be regulated by proper knowledge of the materials he may have to work with—how each may best be applied or acted upon, and what effects will ensue from their different combinations'.¹¹

It has been suggested that these early steps towards convergence ultimately led nowhere: only with the arrival on the scene of Justus Liebig some forty years later did chemistry start to permeate the practice of agriculture.¹² But this is to overlook developments in soil analysis and plant nutrition that deserve separate discussion and, of course, the fact that the publications of the Scottish natural philosophers and the experimental work of Dr Joseph Priestley in England were widely reported

⁸ It was translated into English as *The Natural and Chemical Elements of Agriculture* by John Mills F.R.S. in 1770 and into French in 1793 on orders from the Comité de Salut Public of the embattled First Republic.

⁹ Francis Home, *The Principles of Agriculture and Vegetation*, 3rd edn. (London, 1776), p. 16.

¹⁰ George Fordyce, *Elements of Agriculture and Vegetation* (London, 1771).

¹¹ Dundonald, *A Treatise Shewing the Intimate Connection that Subsists between Agriculture and Chemistry*, pp. 8, 151.

¹² Smout, 'A New Look at the Scottish Improvers', 138–9.

and discussed on the Continent. The French chemists—Guyton de Morveau, Fourcroy, Berthollet, Hassenfratz, and above all Chaptal—were all conversant with Scottish and English authors' attempts to demonstrate how the physical sciences might be brought to bear on the business of food production. Indeed, in an era of intermittent economic warfare and blockade they made it their business to keep up with such developments. The same may be said of Albrecht Daniel Thaer, although his *Grundsätze der rationellen Landwirtschaft* relied heavily on a conceptualization of chemistry which must have appeared rather old-fashioned by the second decade of the nineteenth century.

The Napoleonic Wars, particularly, concentrated minds on either side of the Channel inasmuch as the struggle generated as one of its by-products a chemically informed search for higher yielding bread grains and for crops that could be introduced and grown as import surrogates. The quest for a type of beet from which sugar could be extracted in industrial quantities is a case in point and one which will be explored later on in this chapter. In France the experience of a war economy and the lesson that theorists and practitioners needed to work more closely together was distilled by the Comte de Chaptal in his two volume *Chimie appliquée à l'agriculture* published in 1823 (see chapter five). He cited approvingly the work of Sir Humphry Davy who had begun to deliver his pronouncements on agricultural chemistry from the podium of the Royal Institution's lecture theatre in 1803. A version of his lectures was eventually published in 1813. It seems unlikely, though, that Davy succeeded in bridging the savant-practitioner divide since his understanding of agriculture and soils was not commensurate with his knowledge of chemistry.¹³ French agronomists, as opposed to chemists, found the *Elements* to be rather disappointing and criticized his attempts to ascribe nutritional values to different cereals and vegetables.¹⁴

EXPERIMENT AND OBSERVATION

The problem as nearly everyone recognized by this date was that the study of agriculture lacked an approved experimental method. Davy had been aware of the need to carry out experiments into soil fertility in readiness for his lectures, but they appear to have been somewhat rushed and lacking in appropriate contextualization as Mathieu de Dombasle pointed out in his critique (the farmer can learn more about soils by walking his fields, and more quickly, than the chemist in his laboratory).¹⁵ Research into agriculture, it was commonly supposed, involved too many hard-to-control variables which, moreover, demanded inordinate amounts of time and close supervision if they were to be put to the test of a complete round

¹³ Frank A. J. L. James, '“Agricultural Chymistry is at present in it's infancy”: The Board of Agriculture, The Royal Institution and Humphry Davy' (unpublished paper, 2014).

¹⁴ See *Examen critique des élémens de chimie agricole de M. Davy par C.-J.-A. Mathieu de Dombasle* (Paris, 1820).

¹⁵ *Examen critique des élémens de chimie agricole de M. Davy par C.-J.-A. Mathieu de Dombasle*, pp. 33–4.

of experiments. One potential solution was to bring the activity of growing plants and raising stock 'in house', that is to say into the laboratory or the stall. But this raised the question posed most acutely by the researches of the German chemist Liebig: should the newly minted agricultural science proceed by induction (the verification of observed facts) or by deduction? It is nonetheless true that open-air experimentation in husbandry has quite a long history even if Enlightenment commentators were rather sceptical as to whether any incremental progress had actually been made by the end of the eighteenth century. Launching his work on the 'principles' of agriculture, Francis Home wrote, 'Books on that art we are not deficient in, but the book which we want is a book of experiments'.¹⁶

Unsystematic experimentation with different crops can be traced back to the middle of the seventeenth century, but it was chiefly confined to pots and trial plots and not normally sustained over more than one cycle of growth. From 1699 Jethro Tull carried out field-level experiments which were described in his work *The New Horse-Houghing Husbandry* (1731). Some of these experiments were replicated and verified by the French savant H.-L. Duhamel du Monceau, working in collaboration with his brother on the family estate near Pithiviers. Generally speaking, however, such trials were little more than the gropings of amateurs¹⁷ in the direction of a scientific methodology which could be trusted to produce reliable results in a wide range of contexts. Whether sponsored by enlightened landowners or the plethora of improvement societies established in the second half of the eighteenth century they rarely produced data that could be generalized. Small-scale and episodic trials carried out in atypical conditions were the bane of the German Economic Societies as H. E. Lowood has observed.¹⁸ It was not until the second quarter of the nineteenth century, in fact, that a robust experimental methodology attuned to the realities of 'extensive', open-field agriculture began to take shape. The difficulties were quite daunting and it comes as no surprise to find that the 'book of experiments' which Home called for in 1756 was not published until nearly a century later.¹⁹ Data recording proved a perennial problem inasmuch as investigators tended not to note down all the costs of cultivation and all the returns; precise weighing and measuring of inputs and outputs was in its infancy; and little attention was paid to achieving uniformity in the soil medium. Often enough results were simply extrapolated on the basis of a single agricultural cycle. The 'control plot' seems to have been employed for the first time around 1805 by John Wright of Pickworth in Rutland when carrying out tests for the Board of

¹⁶ Cited in Handley, *The Agricultural Revolution in Scotland*, p. 14.

¹⁷ In a letter to the chemist Pierre-Joseph Macquer, the one-time French minister and botanist Chrétien Guillaume de Lamoignon de Malesherbes defined an amateur as 'any man who knows more about a science than the public knows about it, and less about it than those who are capable of composing, inventing or carrying out useful works.' Amateurs, he continued, should resist the temptation to turn themselves into authors, see Pierre Grosclaude, *Malesherbes. Témoin et interprète de son temps* (Paris, 1961), p. 496.

¹⁸ Lowood, 'Patriotism, Profit and the Promotion of Science', pp. 87, 133, 145.

¹⁹ See James F. W. Johnston, *Experimental Agriculture Being the Results of Past, and Suggestions for Future Experiments in Scientific and Practical Agriculture* (Edinburgh and London, 1849).

Agriculture.²⁰ As for randomization as a principle of experimentation, it lay in the future.

The determination and consistency with which Arthur Young defended an experiment-based approach to agricultural improvement serves only to remind us how prevalent was the scepticism that cultivated Nature could be understood and tamed in this way. His contemporary as an agricultural writer, William Marshall, was far less sanguine. Even as late as the 1830s, John French Burke expressed serious misgivings on the subject of field trials:

First, they are generally made with a view to establish some peculiar theory, or to try the effect of some novel idea... *Secondly*, they are usually conducted on a small scale, on ground peculiarly adapted to the purpose, and attended to with a degree of care that cannot be extended to an entire farm... *Thirdly*, even supposing those objections to be obviated—the experiment to be conducted without prejudice, and managed by an intelligent husbandman on the common field plan—still there are so many circumstances of season, soil and culture which operate differently at different times, without any assignable cause, that what prospers this year fails the next, and what succeeds with one man does not thrive with another.²¹

Arthur Young had learned from mistakes made as a tenant farmer at the start of his career; mistakes unwittingly recorded for posterity in a hefty book entitled *A Course of Experimental Agriculture* published in 1770. His recollection when editor of the *Annals of Agriculture* of a ‘thirst for experiment without the knowledge of what an experiment demands; and what a series of proofs alone can give’²² clearly alludes to his lifelong embarrassment at the exaggerated and overly optimistic tone of this youthful publication which laid claim to hundreds if not thousands of experiments in just a few years. He initially adopted a deductive method rooted in preliminary reasoning, but experience soon taught him that ‘experiment must precede reasoning; and that in agriculture, it is somewhat necessary to act before we think’.²³ Yet once Young had learned what experimentation truly entailed, he never flinched from recommending it to others whilst acknowledging that some experiments failed, or produced negative results. He became an ardent quantifier and where numerical data were lacking or in short supply he evolved an inferential methodology rooted in material signs discerned by his own enquiring eye.²⁴ This approach is much in evidence in his agricultural tours, particularly his tours of France. By the 1790s we find a man much more confident in his capacity to draw reliable conclusions from field trials. He reported a six-year experiment with crop rotations to the *Annals* in 1794, and two years later a trial of various artificial

²⁰ George E. Fussell, ‘The Technique of Early Field Experiments’, *Journal of the Royal Agricultural Society of England*, 96 (1935), 87.

²¹ John F. Burke, *British Husbandry*, ii, pp. 112–13.

²² *Annals of Agriculture*, 15 (1791), 154–5.

²³ Arthur Young, *A Course of Experimental Agriculture containing an exact Register of all the business Transacted during Five Years on near Three Hundred Acres of Various Soils including a variety of Experiments on the Cultivation of all Sorts of Grain and Pulse, both in the Old and the New Methods [...]* 2 vols. (London, 1770), i, p. v.

²⁴ Bruyn, ‘From Georgic Poetry to Statistics and Graphs’, 7–8; also Jones, ‘Arthur Young (1741–1820): For and Against’, 1104.

grasses. We know that by 1803 the crop rotation experiments on his much enlarged farm at Bradfield in Suffolk involved twenty-nine fields of between one and twenty acres cultivated on a twenty-one-year cycle. Significantly he no longer planted clover since the land, as others were beginning to discover in Denmark and elsewhere, could be exhausted by over-exposure to the legume.²⁵

Some of the advice proffered by Young and other pundits may have rubbed off, for the La Rochefoucauld brothers whose travel journals contain much of interest to the agricultural historian characterized the English as having an experimentalist approach to farming. Even small farmers appeared to be intelligent experimenters, they noted. Not only were they effective gatherers of information (via neighbours and field clubs), they incorporated the information gleaned into their farming practices in a singularly methodical fashion.²⁶ It has been argued, of course, that an all-embracing culture of experimentation suffused English life in the century after Boyle and Newton, infecting gentleman-savants and urban craftworkers every bit as much as landowners and tenant farmers.²⁷ Young's career as a writer on agricultural affairs can be read as capturing this generational turning away from purely speculative modes of thought. He admonished readers on another occasion with the declaration that, 'every rational mind is impressed of the necessity of making experiments the road to truth. Theory and hypothesis, which long possessed an undue empire in the human mind, are at last dispossessed from their usurpation, and nature brought by philosophers patiently and steadily to the test of experiment, discloses her secrets to those whose industry deserves her confidence'.²⁸ Sir John Sinclair shared this outlook. In his preface to *The Statistical Account of Scotland* (1791–92) he hailed the onward march of natural philosophy which had banished 'visionary theory'²⁹ and replaced it with facts validated by rigorous experimentation.

The evolution of the experimental method in agriculture would not conform exactly to these precepts, however. Increasing availability of 'statistical' information in the early decades of the nineteenth century, together with new State-driven preoccupations such as anxiety over food sufficiency, subtly altered the relationship between science and husbandry. Explicit hypothesis-testing crept back on to the research agenda and more advanced forms of mathematical analysis were brought to bear on the expanding bodies of data available to investigators, enabling them to achieve a degree of standardization in field-trial design that neither Young nor Sinclair would have thought possible, or even desirable. The chemist attached to

²⁵ John G. Gazley, *The Life of Arthur Young 1741–1820* (Philadelphia, 1973), p. 459; also Fellenberg, *Vues relatives à l'agriculture de la Suisse et aux moyens de la perfectionner*, p. 107 and Kjaergaard, *The Danish Revolution*, pp. 82–5.

²⁶ Scarfe, *A Frenchman's Year in Suffolk*, p. 148.

²⁷ See Margaret C. Jacob and L. Stewart, *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687–1851* (Cambridge, MA, 2004) and Joel Mokyr, *The Enlightened Economy: An Economic History of Britain, 1700–1850* (New Haven, CT, 2009), but note the dissenting view expressed by Allen, *The British Industrial Revolution*, pp. 252–5.

²⁸ *Annals of Agriculture*, 5 (1786), 17–18.

²⁹ Quoted in Davidson, 'The Scottish Path to Capitalist Agriculture: 3 The Enlightenment as the Theory and Practice of Improvement', 14.

the Highland and Agricultural Society of Scotland, James Finlay Weir Johnston, pointed the way ahead in his landmark book *Experimental Agriculture* (1849). Johnston was no fan of experiments carried out by individual farmers and he inclined to the view that the increasingly complex procedures presupposed by best-practice field trials could be handled more effectively by a corps of full-time 'professional experimenters'.³⁰ Analytical chemistry should be employed to ensure that test plots were all of the same composition in terms of soil fertility; their size and shape should be optimized; and nothing left to guess-work or chance when weighing and measuring. Nevertheless, a margin (5–10 per cent) could properly be allowed for natural variation. These precepts were beginning to be followed in a few places by the time his book came out. At Rothamsted, as we shall see, John Bennet Lawes established continuous test plots for the major farm crops, and adapted their shape from strips to rectangles.³¹ With his chemist collaborator, Joseph Henry Gilbert he would also start to publish, in 1847, *The Rothamsted Memoirs on Agricultural Science*.

SOIL FERTILITY AND PLANT NUTRITION

In the third edition of *The Principles of Agriculture and Vegetation* Francis Home noted that farmers usually distinguish soils by their colour 'or some other superficial quality, which immediately strikes the senses'. However, 'colour', he declared, 'can never lead to the composition or the principles of bodies, on which alone their effects depend'.³² Attempts to uncover the structure and fertility of soils can be traced back to the latter part of the seventeenth century when John Evelyn, gardener and diarist, carried out 'unsophisticated', investigations, that is to say experiments untrammelled with theory.³³ However, as E. J. Russell points out, it was quite some time before analysis proceeded beyond 'the ancient method of rubbing a moist clod between fingers and thumb: if the soil stuck it was good, but not otherwise'.³⁴ Of course farmers had long known that animal dung, to take an example, when mixed into the soil tended to promote crop growth. Why this was so remained unclear though, even to chemists, in spite of the fact that their ability to analyse both soils and manures was advancing quite rapidly by the 1830s. A body of opinion simply took the view that that there was little point to soil investigation since the earth was no more than a passive growing medium. When Sir

³⁰ Sir E. John Russell, *A History of Agricultural Science in Great Britain, 1620–1954* (London, 1966), p. 133.

³¹ Edward M. Crowther, 'The Technique of Modern Field Experiments', *Journal of the Royal Agricultural Society of England*, 97 (1936), 55.

³² Home, *The Principles of Agriculture and Vegetation*, p. 21.

³³ Therese O'Malley and Joachim Volschke-Bulmahn (eds), *John Evelyn's 'Elysium Britannicum' and European Gardening*. Published by Dumbarton Oaks Research Library and Collection Washington, DC as vol. 17 in the series Dumbarton Oaks Colloquium on the History of Landscape Architecture (Dumbarton Oaks, 1998), p. 271.

³⁴ Russell, *A History of Agricultural Science*, p. 64.

John Sinclair's *opus* on agriculture (*Code of Agriculture*, 1821) appeared in a French translation, it was criticized for its neglect of the chemical analysis of soils.³⁵

Albrecht Daniel Thaer is often cited as the premier 'soil scientist'³⁶ of the Agricultural Enlightenment generation on the ground that he introduced techniques of analysis rooted in quantification and modelling. However, the story seems to be more complicated than a retrospective narrative of the forerunners of modern pedology might suggest. The Scottish savant James Hutton proposed a system of husbandry that would ensure that the fertility of the soil was maintained. This was shortly after the finished version of his *Theory of the Earth* appeared in 1795. It can be found in a long treatise on agriculture which has survived in manuscript form, but probably never saw the light of day.³⁷ Hutton was contributing to an English-language debate on soil fertility which can be traced back to Stephen Hales³⁸ in the early part of the eighteenth century, a debate which was now acquiring explicitly quantitative underpinnings. Hales pioneered an experimental approach to vegetable growth which dwelt less on the organic structure of plants than on the agents (water, soils, and air) which nourished the sap and fostered root development. His aim was to offer husbandmen practical advice on how to loosen and improve the earth and achieve a better match of plants to soils. About a decade after Hutton's death in 1797 this branch of knowledge was starting to be labelled 'agricultural statics'—in other words the science of the balance between nutrient removal (from the soil) and nutrient supply (either via fallowing, the opening up of new ground, or the addition of fertilizing products). The term first appeared in German (*Statik des Landbaus*) making it rather difficult to trace the etymological filiation back to Hales and the British writers and experimenters. However, the link may have been the multilingual Hamburg merchant turned exemplary farmer and philanthropist, Baron Caspar von Voght, who spent three years between 1792 and 1795 studying agriculture and natural philosophy in England, Scotland, and Ireland.

Caspar Voght knew of the work being carried out in this sphere by Thaer and Carl von Wulffen, but conducted his own experiments and trials on the farm and estate at Klein-Flottbek—intermittently it appears, because continental warfare and troop movements prior to 1815 greatly hindered his operations. A former pupil of Thaer's institute at Möglin, Wulffen theorized Thaer's experiments into soil fertility, establishing a number of parameters which are still considered to be relevant. His model expressing the balance between forces exhausting the soil and those capable of replenishing or restoring its fecundity was expressed mathematically in a work published in Berlin in 1815.³⁹

³⁵ *Bulletin des sciences agricoles et économiques*, 3 (1825), 321–3.

³⁶ Feller et al., "The Principles of Rational Agriculture" by Albrecht Daniel Thaer', 696.

³⁷ Jones, 'James Hutton's Agricultural Research', 575.

³⁸ Stephen Hales BD, FRS *Vegetable Staticks: or, an Account of some Statical Experiments on the Sap in Vegetables: being an Essay towards a Natural History of Vegetation* [...] (London, 1727).

³⁹ Carl von Wulffen, *Versuch einer Theorie über das Verhältniss der Ernten zu dem Vermögen und der Kraft des Bodens, über seine Bereicherung und Erschöpfung* (Berlin, 1815); he used the term agricultural statics in 'Sendschreiben an den Herrn Staatsrath Thaer über die Statik des Landbaues', *Möglinische Annalen der Landwirtschaft*, 2 (1818), 238–65.

Both Voght and the British experimentalists seem to have considered this short book which elaborated and generalized many of Thaer's key ideas about soils to be the true foundation of 'la statique agricole'⁴⁰ or agricultural statics. Voght became a keen advocate of the new science and recalibrated his own experiments to make them comparable with those of Thaer and Wulffen. Yet Thaer's observational mode of presentation which did not make use of algebra had the more lasting impact on Europe's budding agronomists. In 1819 the English agricultural commentator William Jacob visited Möglin and was escorted around the estate. 'Much attention', he noted, 'is paid to the analysis of various soils, and the different kinds, with the relative quantities of their component parts, are arranged with great order and regularity'. The specimens were displayed under glass using a curiously old-fashioned colour-coding arrangement for identification, 'if the basis of the soil be sandy, the glass has a cover of yellow paper, if the next predominating earth be calcareous, the glass has a white ticket on its side; if it be red clay, it has a red ticket; if blue clay, a brown one'.⁴¹

Unsurprisingly, the preoccupation with manures as a natural fertilizer developed in tandem with experimental work on soils. In a trenchant comment on the Norfolk Four Course William Marshall wrote in 1795, 'No dung—no turnips—no bullocks—no barley—no clover—nor... wheat'.⁴² This shift appears to have been occurring across Europe: in Sweden around the turn of the century agricultural journals moved the main focus of their attention from the rotation of crops to manuring and soil improvement, particularly the issue of marling.⁴³ Of course, Jethro Tull had declared that plants were fed with tiny particles of soil taken up by their roots, a theory which dispensed with the need for the additive of animal manure altogether. Many a mid-eighteenth century agronomist was seduced, briefly, by this proposition (Duhamel du Monceau, Wöllner, Rantzau-Ascheberg, etc.) and experiments which employed Tull's soil management techniques were duly undertaken. However, it contradicted the doctrine of the four elements; notably Aristotle's conviction that plant life was sustained by suitably prepared organic matter in the soil which was absorbed via the roots.

This was the origin of the 'humus theory' of plant nutrition which, buttressed by vitalism, held sway throughout the period of Agricultural Enlightenment. However, the humus theory was unable to spell out in detail how plants actually received their nourishment and therefore did not deter *aficionados* of the new gaseous chemistry from extending their speculations to plant biology. The English theologian-savant Dr Joseph Priestley had uncovered by experiment in the 1770s the fact that plants were able to absorb noxious gases and restore the quality of the air, and in the early 1780s he and Arthur Young maintained a lively correspond-

⁴⁰ See *Bulletin des sciences agricoles et économiques*, 8 (1827), 218–27; 18 (1831), 144–76.

⁴¹ William Jacob, *A View of the Agriculture, Manufactures, Statistics, and State of Society of Germany and Parts of Holland and France taken during a Journey through those Countries in 1819* (London, 1819), p. 184.

⁴² Cited by Overton, 'The Determinants of Crop Yields in Early Modern England', in Campbell and Overton (eds), *Land, Labour and Livestock*, p. 284.

⁴³ Myrdal, 'Agrarian Literature in Scandinavia and in Britain, Ireland and North America', pp. 15–16.

ence on the subject of nutrition. Priestley satisfied himself that phlogiston was the critical ingredient ('tho' I have no doubt but that phlogiston is the essence, as we may say, of the food both of plants and animals, they are not capable of extracting it except from certain substances').⁴⁴ Whilst not dissenting, Young was more interested in determining the chemical properties of different spring waters with a view to the floating of meadows. He sent flasks up to Birmingham for Priestley to test in his laboratory and received the cautious response that the 'fitness of water for meadows may depend on something besides the phlogiston it contains', plus the admission that 'I know of no method of conveying phlogiston to the roots of plants'.⁴⁵

Any progress in investigations beyond this point proved exceedingly difficult to make. A contributor to the *Annals of Agriculture* declared in 1799, admittedly at a time when little scientific news was reaching Britain from the Continent, that in the current state of knowledge 'The conclusion that follows... is that plants subsist wholly upon water and those gases, or aërial fluids we have mentioned; which either float in the atmosphere, or are emitted by the fermentation of manures'.⁴⁶ If they followed these learned discussions at all, practical farmers must have found them rather perplexing. Doubtless they concluded along with the Scot Robert Brown of Markle that theories about how precisely plants obtained their food were 'numerous and divergent' and 'not to be comprehended by the human mind in its present state'.⁴⁷ However, just a few years before this observation was made Nicolas-Théodore de Saussure, professor of chemistry and mineralogy in Geneva, had published the fruits of his experiments which brought new and well-documented evidence to the debate.⁴⁸ From a platform of carefully conducted experiments using precision instruments (a eudiometer) Saussure determined that atmospheric carbon dioxide was the main source of carbon for plants. This challenged conventional wisdom that plants derived all their food requirements from decomposed vegetable material in the soil, in other words humus. It laid the ground-work for a mineral-based theory of nutrition, although Saussure would not altogether abandon the proposition that plants obtained a portion of their nourishment from soluble organic matter.

SUGAR FROM BEET

By this date some quite significant developments were taking place within the cosmopolitan community of chemists which would have important implications for arable farmers and for farming in general. A case in point is the identification in 1807 by Isaac-Bénédict Prévost of a copper salt fungicide capable of killing smut

⁴⁴ B. L. Add MSS 35126 Priestley to Young, Birmingham, 1 July 1782.

⁴⁵ B. L. Add MSS 35126, Priestley to Young, Birmingham, 27 January 1783.

⁴⁶ Rev. James Headrick, 'Effects of Manures in the Production of Plants', *Annals of Agriculture*, 33 (1799), 299.

⁴⁷ Fussell, 'Science and Practice in Eighteenth-Century British Agriculture', 15.

⁴⁸ Nicolas-Théodore de Saussure, *Recherches chimiques sur la végétation* (Paris, 1804).

spores on cereals. He was another Swiss savant, albeit one living in the semi-obscurity of provincial France.⁴⁹ The successful extraction of sugar from native European varieties of beet which had hitherto been cultivated solely as fodder crops is a further example. Along with the Swedish turnip, the mangold, and the potato, beet would signally alter the aspect of the fields in parts of continental Europe from the middle of the nineteenth century. The chemistry of distilling sugar from the juice of crushed beet was pioneered in Berlin by Andreas Sigismund Margraff in 1747. His, however, was essentially a laboratory demonstration of feasibility and it was Margraff's pupil and successor, Franz Karl Achard, who was the first to acknowledge the commercial potential of the demonstration and to take steps towards scaled-up industrial production. The King of Prussia gave his backing to the project and trials took place between 1786 and 1801. They resulted in the establishment of the first sugar beet factory on Crown land at Gut Kunern near Steinau in Silesia.

Arthur Young got wind of these developments when in 1803 the Swedish gentleman-savant, Chevalier A. N. Edelcrantz, sent him from Berlin a sample of the beet seeds being used in sugar manufacture. The British, however, could afford to be relaxed about this promising application of chemical science to agriculture since they were in control of the Atlantic sea lanes and experienced little difficulty in obtaining supplies of refined cane sugar from the Caribbean. The rest of Europe, by contrast, was faced with a sugar famine when the Amiens peace accords broke down and the struggle for continental supremacy resumed—hence the urgency in pushing forward the quest for a high-yielding import substitute crop. Additional factories were set up in Pomerania and Brandenburg and the Russian Emperor ordered one to be built near Tula in 1802 which seems to have used Achard's method of extraction and crystallisation. In that year Gut Kunern managed to process about 400 tons of beet and to extract about 4 per cent of its sugar content. However, the operation was brought to a halt and then subsequently ruined by fire when Frederick William III of Prussia entered the war against Napoleon in 1806.

In France and the territories controlled by France huge pressure would be exerted on farmers to plant sugar beet, but only after efforts to produce a crystalline sugar from grape syrup had failed.⁵⁰ Such was the urgency of the situation that enterprising individuals were encouraged with subsidies to set up refineries even before the Institut National (successor to the Académie Royale des Sciences) had verified Achard's published test results,⁵¹ or a supply of the vegetable raw material could be guaranteed.⁵² In 1811 the government stipulated that the prefects should ensure the planting of 32,000 hectares with the crop throughout the Empire and the following year this area was raised to 100,000 hectares. Yet seed was in desper-

⁴⁹ For the diffusion of this technology in south-west France, see Théron de Montaugé, *L'Agriculture et les classes rurales dans le pays toulousain*, pp. 195–6.

⁵⁰ Spary, *Feeding France*, pp. 285–92.

⁵¹ Franz K. Achard, *Die europäische Zuckerfabrication aus Runkelrüben*. 3 vols. (Leipzig, 1809).

⁵² See Jonna M. Yarrington, 'Droits and Frontières: Sugar and the Edge of France, 1800–1860' (MA dissertation, University of Arizona, 2014), p. 54; also Hugh D. Clout and A. D. M. Phillips, 'Sugar-Beet Production in the Nord Département of France during the Nineteenth Century', *Erdkunde*, 27 (1973), 106.

ately short supply, as was even the most elementary understanding of cultivation requirements. Only around 7,000 hectares of beet were actually planted at this juncture, it appears. In the Belgian departments whose quota was 13,400 hectares, the area planted was derisory.⁵³ Yet in 1812–13, the last uninterrupted agricultural year before the invasion, domestic sugar output surpassed 1,000 metric tons⁵⁴ and by the 1830s France would be producing more sugar from beet-root than any other country in Europe.

C.-J.-A. Mathieu de Dombasle who is better known to us as the tenant of Roville model farm and one of the precursors of vocational agricultural education launched his career as a scientifically aware estate manager with a business distilling sugar from beet juice in 1809–10. He was therefore one of the pioneers of industrial sugar production in France and, as he tells us, frequently obliged to resolve the chemical, the technological, and above all the agricultural problems attendant on beet processing, whether in the factory or out in the fields.⁵⁵ Although he was familiar with Margraff's researches, he only read Achard's account of his activities after he had embarked on production. By this date most would-be sugar manufacturers accepted that the white fodder beet grown by farmers in the neighbourhood of Magdeburg and subsequently planted extensively in Silesia contained the highest concentrations of sugary juice.

However, this particular strain of the *beta vulgaris* was not widely cultivated in France and scarcely at all in Lorraine where Mathieu de Dombasle set up his processing plant. Beet seed, moreover, was multi-germ which precluded drilling and necessitated labour-intensive thinning. It was cropped on a two-year agricultural cycle, normally in the mid-autumn, which in turn made it extremely difficult to insert into the rigid cereal rotations of the region. Beet demanded deep and friable soils subject to careful preparation, particularly in Lorraine where the ground was intrinsically fertile but consisted largely of kuyper marl clay which resisted the action of farm implements. The Dombasle plough which reduced drag and permitted a deeper cut was doubtless theorized in the light of its creator's beet-growing experiences. Finally, trial and error methods taught that field-cultivated beet responded best when close planted, if only to smother weeds.

Although beet-root was a potentially lucrative crop given the price support put in place in the 1800s and 1810s, persuading farmers to grow it was no easy matter. Lorraine was an unenclosed open-field environment given over to grain production on a traditional three-year rotation. If the beet were sown in the fallow field, the ground needed to be completely weed-free and friable beforehand, which presupposed a great deal of village labour expended on cleansing and deep ploughing. However, since it could not usually be lifted (another onerous activity) until the month of October, its presence in the soil inevitably impeded the sowing of winter cereals. After considering a number of solutions Mathieu de Dombasle came to the conclusion that growing beet as an industrial crop would necessarily involve a

⁵³ Goossens, *The Economic Development of Belgian Agriculture*, p. 74 and note 63.

⁵⁴ Clout and Phillips, 'Sugar-Beet Production in the Nord', 108.

⁵⁵ Christophe-Joseph-Alexandre Mathieu de Dombasle, *Faits et observations sur la fabrication du sucre des betteraves* (Paris, 1821).

four-course rotation: wheat, sugar beet, barley or oats perhaps under-sown with clover, clover.

Yet farmers were initially reluctant to alter their rotations even to accommodate a potentially rewarding cash crop. The suspicion persisted in Lorraine that root cultivation of any description tended to exhaust the soil; in fact a few landowners even banned such innovations in prescriptive leases. Mathieu de Dombasle therefore found it necessary to invest capital in the purchase of land in the vicinity of his factory and to place a large number of independent growers under contract, reserving the delicate business of sowing and lifting to his own specialized labour force. In practice this resulted in an agro-industrial operation involving farmers located in seven or eight villages situated up to seven kilometres apart whose ploughing practices needed to be carefully supervised. The beet seedlings, he discovered, were sensitive not only to soil preparation but also to soil variation, hence the need to plant on a radius of scattered strips rather than on large conveniently accessed blocks of arable. Although other 'experts' such as the Comte de Chaptal envisaged that beet for sugar could be grown on large-scale consolidated farms, Mathieu de Dombasle begged to differ. He pointed out that the labour requirement alone made its cultivation a branch of *petite culture* on a par with tobacco, madder, or saffron where profit and productivity turned mainly on the use of family labour.

Always keen to quantify his experiences wherever possible, Mathieu de Dombasle calculated that in order to satisfy domestic demand, France required around 500 manufactories each capable of producing 40,000 kilograms of sugar from beet annually. To achieve this level of output every refinery would need to command a beet 'hinterland' of around eighty *hectares*—on the assumption that the designated land could produce a crop annually. But of course it could not in an age which had yet to uncover the power of artificial fertilizers, irrespective of whether a three- or a four-course rotation was adopted. His own operation was ambitiously conceived to process about 14,000 kilograms of beet-root a day (over a 150-day cycle of continuous production). However, he never achieved this target and by the time the invasion brought activity to a premature halt in 1813–14 (his horses were requisitioned by the army, his premises occupied by Allied troops and the un-harvested crop left to rot in the ground) he had managed to produce about 91,000 kilograms of sugar in total.⁵⁶

In the memoir which recounts these experiences Mathieu de Dombasle also tells us quite a lot about how from his provincial outpost far removed from the savants of the capital he tried to improve the technology of sugar extraction, a process which was quite complex if scarcely at the cutting edge of science by the early nineteenth century. It involved chopping and crushing; the repeated heating and slow cooling of liquids under the supervision of workshop overseers; cleansing with additives (lime), purification, boiling, filtration using animal charcoal; and crystallisation. He introduced cylindrical chopping drums but soon abandoned crushing with mill-stones as the Prussian chemists had recommended on the

⁵⁶ For this paragraph, see Mathieu de Dombasle, *Faits et observations*, pp. xviii–xx, 182, 215.

ground that it released only 30 per cent of the juice. Instead, he adopted an iron screw-press.

In general the procedures followed by the sugar cane planters of the Caribbean served as his guide until by a process of trial and error they were found wanting: the slow stoving of the syrup in order to achieve crystallisation as practised in Germany gave way to cooking on an open fire and he was alert to the possibility of using steam as a heat source. In 1813 an exchange of technological information took place in rather unusual circumstances when Johann Georg von Koppy who was serving in a Prussian Cossack corps paid the factory a visit in the midst of the invasion of France. Koppy was the son of Baron Moritz von Koppy, one of Achard's collaborators who had set up his own processing plant on his Krayn estate close to Gut Kunern. According to Mathieu de Dombasle the scientific and technical knowledge flows had been reversed by this date, though, and Koppy took away with him from the inspection more than he brought to it.

Sugar beet encouraged the development of the science of agriculture in the early decades of the nineteenth century in two ways. The maximization of yields was fundamentally an issue for chemists as we have seen, whereas the cultivation of the root on a truly extensive scale in France and in Germany was predicated on the availability of 'artificial manures' and the willingness of farmers to make use of them. By 1836 the French July Monarchy government had managed to get around 20,000 hectares of arable land into regular beet production and by 1850 the national crop was generating 75,000 metric tons of sugar annually (300,000 tons by 1870).⁵⁷ Yet this outcome could scarcely have been foreseen when the first refineries were set up in a response to Haitian independence (1804) and the Continental Blockade (1806–14). When Achard communicated his results via the Republic of Letters the French chemists were dubious.⁵⁸ They doubted whether the soils of France were suited to large-scale beet growing and, in any case, would have preferred a solution involving the extraction of table sugar from grapes—an agricultural crop in superabundant supply. In the early years sugar from beet was a 'boom-and-bust' industry for all parties, and one which a prudent farmer would not necessarily have embraced. Only well-capitalized entrepreneurs survived in the business and Mathieu de Dombasle was not one of them. By 1828, the year in which he finally sold off his long-abandoned manufacturing site, there were reputed to be around 250 functioning refineries in the north and east of the country.⁵⁹ However, they were unable to meet the domestic demand for sugar as Mathieu de Dombasle had anticipated and the colonial product continued to be imported.

⁵⁷ 'Betteraves et sucre: une contribution majeure à l'économie agricole champardennaise', *Agreste Champagne-Ardenne*, 6 (May 2009), i. <http://www.draaf.champagne-ardenne.agriculture.gouv.fr> (accessed 31 October 2014).

⁵⁸ See Spary, *Feeding France*, pp. 287–8.

⁵⁹ According to Eustache-Marie-Pierre Courtin, *Encyclopédie moderne ou dictionnaire abrégé des hommes et des sciences, des lettres et des arts*. 24 vols. (Brussels, 1827–32), xxi, 379 yet M. Crespel-Dellisse to M. Gay-Lussac, *Annales de chimie et de physique*, 37 (1828), 53–8 lists only thirty-five.

TOWARDS A LABORATORY AGRICULTURE

By this date it was becoming obvious to numerous observers that agriculture could not continue on the old pattern, if only for the reason that population pressure was threatening to destabilize the countryside—particularly in central Europe. However, the apprehension of the need for change registered very unevenly, which helps to explain why States did not all come up with the same solutions at the same time. Governments such as the British, or for that matter the Dutch, saw little need to intervene in what were already highly efficient food-producing sectors, but in the German lands agriculture still required fundamental reshaping if it was to perform the role envisaged for it in the unification process.

Was farming a vocation or a remunerative economic activity like any other; one, moreover, which could benefit from farmers being trained for the job? The question was put with increasing urgency in the 1830s and 1840s. The question was also raised as to how research and experimentation in agriculture should be organized and supported. Was it sufficient to rely on the premium system inherited from the second half of the eighteenth century in an age where scientific investigation increasingly involved continuous expenditure and sustained intellectual effort spearheaded by specialists?

The cameralist curriculum of German and Scandinavian countries had long provided a training of sorts, of course, although not one focused on agriculture for its own sake. In western Europe, however, there was nothing comparable in scope. In Scotland Robert Maxwell of Arkland, secretary to the Society of Improvers in the Knowledge of Agriculture, had urged that husbandry be taught 'in a Collegeway, as other Sciences are'; in fact he suggested the creation of a professorship of agriculture which could be held by a 'practical farmer' who would offer instruction on the basis of 'rational experiments tried in our own Country'.⁶⁰ Such a chair of agriculture was indeed endowed in the University of Edinburgh in 1790, but it did not amount to much and did little to bridge the gap between theory and practice. Arthur Young who had briefly been considered a candidate argued in the columns of the *Annals of Agriculture* that a working farm should be attached to the post. University-trained professors of botany, it should be said, showed scant interest in applying their knowledge to agriculture. In France the first State-sponsored institutions to deal specifically with the rural economy were the veterinary schools established in Lyon in 1762 and in Alfort just outside Paris three years later. The latter had grown into an important centre of agronomic research by the time the Revolution intervened to dismantle most existing institutional structures. It took in pupils who included two lads sent there by the Odiham Agricultural Society to study farriery in 1788.

Attempts to set up schools to train the sons of farmers in the art of husbandry mostly came to nothing in the eighteenth century. A plan to establish some form

⁶⁰ Bonnyman, 'Agrarian Patriotism and the Landed Interest: The Scottish "Society of Improvers in the Knowledge of Agriculture", 1723–1746', in Stapelbroek and Marjanen (eds), *The Rise of Economic Societies*, pp. 48–9.

of agricultural schooling appears to have been discussed in the *Accademia dei Georgofili* of Florence in the 1750s, but with no discernible result.⁶¹ In 1771 a landowner of Annel near Compiègne was encouraged by the French chief minister, Henri Bertin, to provide an estate 'pour servir à des enseignements de toute espèce de culture'.⁶² The aim, it seems, was indeed to educate practising farmers, albeit well-to-do ones (*laboureurs*); however this initiative lapsed with the departure of Bertin from the ministry. A subsequent Controller General briefly considered establishing a school of agriculture on the newly acquired island of Corsica and during the Revolutionary decade there were further proposals of this sort. The new *Ecoles centrales* of 1795 which were designed to fill the gap left behind following the wholesale destruction of the education institutions of the *ancien régime* were supposed to offer instruction in husbandry among other useful things, but there is little sign that they did so. In any case they did not last very long. In France, therefore, it was not until Mathieu de Dombasle decided, in 1822, to attach a teaching institute to his Roville estate that a formal provision for instruction came into being. It is true that before that date Victor Yvert, professor of agriculture at the Alfort veterinary school, had been offering a course of lectures on rural economy.

The relationship between model farms and teaching establishments, a subject we have already touched on in chapter four, is somewhat blurred. The same may be said of the relationship between model farms and agricultural experiment stations. Whilst some model farms developed a teaching vocation, the majority did not. Since they were not, generally speaking, government-supported institutions much depended on the temperament of the individual proprietor or, in the case of the German lands, of the economic or patriotic societies that so often took the lead in such creations. The Roville teaching institute almost certainly owed something to the local landowner Antoine Bertier, an unrepentant Bonapartist and firm believer in mutual schooling who had selected Mathieu de Dombasle to take over the lease of his property on unusually long terms. Although the farm was certainly 'model' in the sense that it demonstrated good practice to all who chose to pay a visit when travelling the post-road between Nancy and Besançon, it proved barely viable as a free-standing agricultural enterprise. Mathieu de Dombasle remained stubbornly uncomplimentary about nearly every aspect of the land he had taken over and one suspects that he derived more satisfaction from the attached school and tool workshop than from day-to-day farming operations.

Emanuel von Fellenberg, the Swiss originator of Hofwyl, seems to have been a moral reformer at heart, an outlook we find quite often associated with those seeking to restore social harmony via recognition of the redemptive value of labour in the fields and in the farmyards. He allocated his pupils to two main groups: the sons of affluent landowners and comfortable farmers and the sons of the poor and vagabonds. The former received a type of instruction which was mainly academic and which included the rudiments of agricultural science, whilst the latter acquired

⁶¹ See Pazzagli, 'From Private Initiative to State Intervention', in Vivier (ed.), *The State and Rural Societies*, p. 232.

⁶² Thérèse Charmasson, Anne-Marie Lelorrain, and Yannick Ripa, *L'Enseignement agricole et vétérinaire de la Révolution à la Libération* (Paris, 1992), pp. vii–viii.

the skills and manual dexterity appropriate to running a farm for the most part. Daniel-Alexandre Chavannes who was sent on a visit to Hofwyl by the Société d'Agriculture of the canton of the Vaud reported to the *Bibliothèque britannique* in 1813 that he had witnessed Fellenberg's schoolmaster Wehrli put his twenty-two poorer pupils through their paces. First their capacity to read from the bible was tested; then their knowledge of arithmetic insofar as it related to weights and measures. In addition to manual tasks, musical training and also gymnastic exercises were prescribed because Fellenberg believed that they helped to soften and mould character.

This particular pedagogic activity resembled what French commentators referred to as an 'école d'industrie'. However, the extensive buildings at Fellenberg's disposal also housed a 'Landwirtschaftlichen Institut' plus facilities for an elite training programme which, at the time of writing, was offered to just twenty pupils drawn from wealthy noble backgrounds. The agricultural institute was based in a chateau at Buchsee a short distance from the Hofwyl estate and it provided both theoretical and practical training in agriculture covering mathematics, chemistry, and natural history. The pupils of the institute were drawn from various parts of Germany and German-speaking Switzerland and they had their own test plots separate from the main estate on which to conduct experiments. Some of the pupils had apparently been selected and sent to Hofwyl on bursaries by their home governments. Was this a project with utopian ambitions, funded regardless of cost? Chavannes insisted that it was not: Fellenberg's intention was not to detach individuals from their social moorings but to reconnect them to the land with benefit both to themselves and to the State.⁶³

In the aftermath of revolution in France and at the height of the Napoleonic Empire it would not have been wise to justify the Hofwyl undertaking in any other terms, of course. Nevertheless, the evidence suggests that it was a rather unusual agrarian educational experiment and was understood as such at the time. Quite apart from its status as an important site of agronomic innovation, Hofwyl was visited by many post-Enlightenment educational theorists from America and elsewhere.⁶⁴ The brief collaboration between Fellenberg and Johann Heinrich Pestalozzi, whose own school at one time occupied premises nearby further enhanced the prestige of Hofwyl. In 1816 it was toured by the Whig politician Henry Brougham who became a convert to Fellenberg's views and compiled a report which was presented to a select committee of the House of Commons. Hofwyl also seems to have inspired the Marchese Cosimo Ridolfi who would set up a teaching establishment—the *Istituto teorico-pratico di agricoltura*—on his Tuscan estate of Meleto in 1834.⁶⁵

⁶³ *Rapport de M^r D. A. Chavannes à ses commettans sur l'Institut d'éducation des pauvres à Hofwyl* [...]. Tiré des 51 et 52^e volumes de la *Bibliothèque britannique. Division littérature* (Paris and Geneva, 1813); see also Y. Maurin, 'Hofwyl vue par les agronomes français: philanthropie ou école d'agriculture modèle?', *Annales d'histoire des enseignements agricoles*, 4–5 (1992), 23–9.

⁶⁴ Donald B. Marti, 'The Purposes of Agricultural Education: Ideas and Projects in New York State, 1819–1865', *Agricultural History*, 45:4 (1971), 274.

⁶⁵ Pazzagli, 'From Private Initiative to State Intervention', in Vivier (ed.), *The State and Rural Societies*, 234.

Emanuel von Fellenberg's pioneering attempt to introduce a form of agricultural education to the canton of Berne did not outlive his death in 1844. The same may be said of Baron Caspar Voght's efforts at Flottbek. He had established a training institution at Gross-Flottbek close by his farm in 1797. In fact the same holds for Roville as well where Mathieu de Dombasle's demise in 1843 put an end both to the agronomic and the educational experiment, although the tool factory went from strength to strength. It seems that only the initiatives of the State, or those proprietorial initiatives taken over by the State, stood any real chance of survival. Thus Albrecht Daniel Thaer's Möglin which can be described as a hybrid institution combining a model farm, an agricultural college and an embryonic research station became the Königlische Preussische Akademie des Landbaus in 1819, Thaer having previously accepted a professorship in agriculture at the new University of Berlin. In a similar vein Heinrich Cotta's forestry school at Tharandt was eventually taken over by the Saxon State to become, in 1816, the Königlich-Sächsische Forstakademie and after 1842 Ridolfi's *Istituto* was continued in the form of an institutionalized School of Agriculture attached to the University of Pisa. Wilhelm I of Württemberg would set up an agricultural academy using the Möglin model too. It was established at Hohenheim in the aftermath of the dearth of 1816–17 in his kingdom.

Russia, by contrast, was situated on the margins of the developments outlined in this chapter. Yet a school was set up in 1822 under the auspices of the Moscow Agricultural Society which had come into existence as a semi-independent body a year earlier. Its first director was the agronomist and propagator of agricultural science in Russia, Mikhail Grigor'evich Pavlov who had studied agriculture under the guidance of Thaer in Germany. The school took out a lease on marshland just outside Moscow in order to establish an experimental farm and it employed as a manager Aleksandr Rogers, the Russian-speaking son of a migrant Scottish couple. Rogers' mother and father were well-known and highly skilled agriculturists who appear to have been brought over by Count Peter Alexandrovitch Rumiantsev. Rogers senior had managed successfully two estates where he pioneered the cultivation of the potato among other plants, whereas his wife built up a farmyard dairy industry which supplied the Moscow market with butter, cheese, and cream. Although the experimental farm under the stewardship of Rogers junior ran at a loss and had to be bailed out by the government, it was able to demonstrate the productivity potential of the scientific approach to the farming of marshland and was instrumental in spreading the cultivation of sugar beet throughout the district.⁶⁶

The 'rational' farmer and experimentalist Albrecht Daniel Thaer whose influence pervaded Germany in the early decades of the new century expected his pupils to have several years' practical experience of husbandry before their arrival in Möglin. Not so Mathieu de Dombasle whose approach was more didactic and involved copious readings from agronomic texts buttressed by language study. This has been questioned by Nagwa Abou El Maaty, however, who detects in Mathieu

⁶⁶ Bradley, *Voluntary Associations in Tsarist Russia*, pp. 75–85; also 'Russian Travelling Sketches, no. 11', in *The New Monthly Magazine, and Literary Journal*, 10 (1825), 209–13.

de Dombasle's mode of instruction the embryo of a new '*pensée agronomique*'⁶⁷ based on practical training, political economy, and farm economics. What is certain is that chemistry did not bulk large in the syllabus prescribed for study. Despite his own researches and experiences as a beet grower and processor, he seems to have regarded the physical sciences as not yet sufficiently developed to have much to offer practitioners of cereal agriculture. Already by 1828 there were forty-five pupils following his instructional programme and by the time of his death around 400 students had passed through the institute. Most, if not all, were the sons of landowners who had been sent to Roville specifically in order to learn management rather than 'hands-on' farming skills.

Yet we should resist the conclusion that the Roville school therefore missed its mark and offered nothing at all in the way of enlightenment to ordinary farmers. In France a number of the first generation of agricultural educationists received instruction in this modest Lorraine village (Auguste Bella at Grignon, Jules Rieffel at Grand-Jouan, Léon de Dombasle at Verneuil, Bruchard at Chavignac, Coche at La Bâtie, etc.) They were all agronomists of a post-Physiocrat stamp who accepted the need to modify the rather austere, *ex cathedra* pedagogy of Mathieu de Dombasle so as to make it more meaningful to a wider spectrum of pupils. As a result mathematics, geometry, and applied chemistry came to be offered alongside skills training in the thirty-odd '*fermes-écoles*' by the middle of the century.⁶⁸ Nevertheless, it is likely that the more numerous and much better connected *comices agricoles* discussed in chapter four had greater success in persuading ordinary farmers to adopt technological change and improved methods of cultivation. Only ten of the farm-based schools in existence in 1845 enjoyed recognition and a measure of financial support from government in any case.

The history of agricultural education for the rural masses has not been an unmitigated success story even in relatively modern times as development economists such as Ester Boserup have remarked.⁶⁹ Bringing an opportunity to the notice of the public—improved implements, irrigation, new seed varieties, and so on—does not translate into automatic 'take-up'. In the 1830s and 1840s voices began to be heard calling for a fundamentally different approach: 'rational' agriculture should be brought in-house; that is to say the entwined activities of scientific enquiry and education should be confined to specialized institutions established and funded by the State in accordance with perceived national priorities. The governments of Prussia and Württemberg had pointed the way in this regard and in France Charles-Edouard Royer, an inspector-general of agriculture, was asked to compile a report on the developments in agricultural education taking place in Germany with a view to adapting them to French conditions.⁷⁰ Whilst he was more complimentary

⁶⁷ K. Nagwa Abou El Maaty, '*La Scolarisation de l'apprentissage agricole en France: les fermes-écoles au service de l'agriculture et de son enseignement (19^e siècle—début 20^e siècle)*'. 3 vols. (Thèse de doctorat, Université de Paris IV, 2007) summary in *Ruralia*, 21 (2007), 1–11.

⁶⁸ Charmasson et al., *L'Enseignement agricole et vétérinaire*, pp. xli–xliii.

⁶⁹ Boserup, *The Conditions of Agricultural Growth*, p. 65.

⁷⁰ *L'Agriculture allemande, ses écoles, son organisation, ses mœurs et ses pratiques les plus récents par Royer inspecteur de l'agriculture* (Paris, 1847).

about the work being done at Hohenheim than at Thae's now venerable establishment at Möglin, Royer managed to put his finger on the problems associated with the institutional approach to Agricultural Enlightenment as they appeared to an informed mid-nineteenth-century observer. There was still a mismatch between theory and practice; institutions, where they existed, tended to sprawl and embrace too many disparate roles and activities; and the training courses offered to apprentice-farmers needed to be considerably revised and extended.

However, this diagnosis would be complicated by a jurisdictional dispute between the two professional groups—agronomists and chemists—now bidding for authority and control over the future shape and direction of agriculture on the Continent. In 1829 Arsène Thiébaud de Berneaud published an otherwise unremarkable *Manuel du cultivateur français* in which he urged the merits of the traditional approach to farming, the alternative being what he termed a 'laboratory agriculture' which was already preparing to take over 'the territory of the first and foremost art'.⁷¹ He was exaggerating of course. Nevertheless, chemistry was making inroads, particularly as the science of manures and plant nutrition began to pick up momentum. Mathieu de Dombasle probably spoke for the majority of farmers when he declared that despite all his stocking efforts over many years he had never been able to generate the 10,000 kilograms of animal muck his land required each year.⁷²

Systematic experimentation employing analytical chemistry on the farm really started in earnest in the 1830s. At Bechelbronn the chemist Jean-Baptiste Boussingault began to apply the quantitative methodology perfected by Nicolas-Théodore de Saussure in his investigations of plant nutrition. Bechelbronn was an Alsatian property that had come to him by marriage in 1834. In England something similar was happening at Rothamsted about thirty miles to the north of London. Here John Bennet Lawes took over his family's home farm of about 250 acres, also in 1834, where he indulged an amateur passion for chemistry using one of the bedrooms of the manor house as a laboratory. Again, it seems to have been de Saussure's widely reported work that spurred his interest in the link between chemistry and agriculture. In the course of experiments he established that animal charcoal treated with sulphuric acid resulted in a highly effective fertilizer. He started to make use of this 'superphosphate of lime' on the farm in 1840 and so successful was it that he patented two years later a manufacturing process for extracting phosphate of lime from all manner of substances.⁷³ The profits of his business as a chemical manufacturer were then ploughed back into agricultural research at Rothamsted. By all accounts Lawes was not a particularly active gleaner of knowledge through reading as opposed to experiment. Many years later he would state that his attention was drawn to the bone question by a neighbour who

⁷¹ Cited in Florian Reynaud, *L'Élevage bovin: de l'agronome au paysan, 1700–1850* (Rennes, 2010), p. 284.

⁷² Villermé, *L'Agriculture française*, p. 28.

⁷³ Edward J. Russell, 'Rothamsted and its Experiment Station', *Agricultural History*, 16:4 (1942), 168. The neighbour, apparently, was Lord Dacre owner of the estate of Kimpton Hoo a few miles distant.

wondered why his lighter soils were improved by ground-up bones, but not his heavy clays.⁷⁴ Both Bechelbronn and Rothamsted evolved swiftly into fully fledged agricultural experiment (i.e. research) stations, although Boussingault would not remain in Alsace for very long whereas Lawes, in partnership with the English chemist J. H. Gilbert, devoted his life and all his resources to the field-trial work carried out at Rothamsted.

Institutionalization and the increasing professionalization of scientific investigation were inimical to the spirit of Agricultural Enlightenment and would bring it to an end. Punctuated by the shock of the attempted revolutions of 1848–49, the agrarian history of Europe in the second half of the nineteenth century belongs to a different era. Both in France and in Germany the future trajectory of agriculture would be tied closely to the chemistry laboratory and the experiment station although the routes taken in this direction were by no means identical as Nathalie Jas has demonstrated.⁷⁵ In Great Britain, by contrast, the State retreated from any direct involvement in agriculture or agronomic research following the successful outcome of the Napoleonic Wars. Whilst admiring Thae's Möglin operations for the high farming standards in evidence there, William Jacob was quite sure that a trail-blazing institution of this type had no useful role to play in England, 'we have already carried the division of labour in agriculture, not certainly so far as it is capable of being carried, but much farther than is done in any other country'.⁷⁶ The mid-Victorians never considered seriously the idea that agriculture should be converted into a profession. Although a Royal Agricultural College came into existence in 1844, it did little in its early years to promote vocational education.⁷⁷ As for science, the British tradition of the gentlemanly amateur died hard. Not until after the middle of the century did governments start seriously to entertain the proposition that the nation might benefit from a greater systematization of scientific instruction.⁷⁸

In France Charles-Edouard Royer's report on agricultural training in the German territories was intended to pave the way for legislation although he died and the July Monarchy succumbed to an outbreak of street fighting in Paris before anything practical could be achieved. Nevertheless the replacement regime moved swiftly to put in place the framework for a nationwide system of agricultural education. At its apex stood the Institut National Agronomique with a mandate to train professors and 'rural engineers', and to carry out research into the science of agriculture. The move to generalize *fermes-écoles* now received the wholehearted support of the State and by 1849 sixty-eight⁷⁹ of these establishments were up and running; the context after all was one of economic crisis and considerable agrarian

⁷⁴ Russell, 'Rothamsted and its Experiment Station', 169.

⁷⁵ Nathalie Jas, *Au Carrefour de la chimie et de l'agriculture: les sciences agronomiques en France et en Allemagne, 1850–1914* (Paris, 2000).

⁷⁶ Jacob, *A View of Agriculture*, p. 187.

⁷⁷ Nicholas Goddard, "'Not a Reading Class': the Development of the Victorian Agricultural Textbook", *Paradigm: Journal of the Textbook Colloquium*, <http://education.illinois.edu> (accessed 19 January 2015).

⁷⁸ Drayton, *Nature's Government*, pp. 175–6.

⁷⁹ Charmasson et al., *L'Enseignement agricole*, p. xlviii.

distress. However, the *coup d'état* perpetrated by Louis Napoléon Bonaparte against the Second Republic in 1851 cut short this development. The newly restored Empire would benefit from two decades of peace and relative prosperity in the countryside and saw no need for a structured programme of rural interventionism. In any case the ministers of the Second Empire preferred chemists to remain ensconced in their academic chairs where they could be closely supervised.

Greater freedom of movement and development existed in Germany which was not yet territorially united. Economic societies, agricultural academies, and pre-existing model farm-cum-experiment stations all contributed to the process of defining a trajectory for agricultural education and research. Yet little would happen until the issue of German nationalism entered the arena of practical politics in 1848. Until that date Germans watched from the sidelines the growth of a science of agriculture in France where the chemist Boussingault was elevated to a chair of agriculture at the Conservatoire des Arts et Métiers in 1845 and within the private sector in England where Lawes and Gilbert had launched their field-trial programme at Rothamsted. After 1850, however, investment in agricultural science accelerated sharply in the German lands and the experiment station steadily took over as the approved institutional model for research. Seventeen *Landwirtschaftliche Versuchsstationen* were founded between 1850 and 1863 and most of them would eventually be headed by chemists rather than agronomists.

This important development lies mostly beyond the scope of the present book. However, it is worth exploring the first stirrings of the agricultural experiment station phenomenon in Germany if only to demonstrate that the transition from a tradition of agronomy based on Young, Sinclair, and Thaer to one of analytical chemistry constructed in the image of Liebig was neither rapid, nor uneventful. The first of the new stations was established on the Möckern estate near Leipzig in 1850. Significantly it was mainly the handiwork of a landowner, Wilhelm Crusius, president of Saxony's oldest improvement society the Leipzig *Ökonomische Societät* founded in 1763. Like many of Germany's biggest proprietors Crusius had been cast from the 'rational' farmer mould. In fact, the occasion which launched the station was a banquet to mark the unveiling in Leipzig of a new marble statue of Albrecht Daniel Thaer. In other words the motivation behind the creation expressed a continuing confidence in the improving capacity of Enlightenment rationalism and experimentalism rather than laboratory-derived results obtained by agricultural chemists with little or no connection to farming. To this can be added an awareness of the need to address some of the social and economic issues brought to light during the revolutions of 1848–49.⁸⁰ Three years after its creation the Saxon government took over full financial responsibility for running the Möckern station.

A good deal of the lay suspicion of chemistry stemmed from Justus Liebig's researches and public pronouncements which included a peremptory dismissal of the farm-gate wisdom of previous generations of cultivators. In 1840 he had published a book entitled *Die Organische Chemie in ihrer Anwendung auf Agrikultur*

⁸⁰ See Finlay, 'Science, Practice and Politics', p. 80.

und Physiologie (*Organic Chemistry in its Application to Agriculture and Physiology*). More or less simultaneous translations into English and French guaranteed the book's impact in scientific circles since it provided a persuasive replacement for the humus theory of plant nutrition and castigated the inductive experimental methodology followed by almost all the theoreticians of Agricultural Enlightenment generation. Liebig, from the recesses of his laboratory in Giessen, deduced that nitrogen, like carbon, came originally from the atmosphere and was brought to earth (as ammonia) by rain. Potassium, sodium, calcium, magnesium, and silica, he declared, all enter the soil by virtue of the weathering of rocks and can be absorbed by plants in solution. From this 'mineral theory' it followed that organic matter was strictly speaking superfluous to soil fertility unless it happened to contain minerals. This, in turn, raised a question about the usefulness of animal dung which farmers routinely and often indiscriminately applied to the land on a 'the-more-the-better' principle. The value of farmyard manure lay not in the odorous organic matter but in the ash residue after it was burned.⁸¹

So there was the 'answer': agriculture consisted of chemical reactions in and between plants, soils, nutrients, and the atmosphere. It could therefore scarcely be expected to flourish and meet the demographic and economic challenges of the nineteenth century if farmers lacked a preliminary grounding in organic chemistry. As the debate triggered by his book got under way Liebig confided to Lyon Playfair, his English translator, that he had written about the 'Chemistry of Agriculture' not 'Agricultural Chemistry'. He added, 'I must avoid anything bearing on practical agriculture.'⁸²

Whilst English and Scottish commentators were quick to acknowledge the potential of Liebig's refashioning of the science of agriculture—a means of feeding a rising population without recourse to food imports—his views encountered considerable scepticism in Germany. A generation raised on the precepts of Albrecht Daniel Thaer simply refused to accept that chemistry was the *only* effective route to agricultural improvement. Research in France by Jean-Baptiste Boussingault into the role played by nitrogen in plant growth seemed to challenge Liebig's science in any case. Moreover, the fiasco of his patent manure was scarcely calculated to inspire confidence. Liebig had had this mineral concoction manufactured in Liverpool and arranged for it to be trialled on Saxon farms in 1845–46. But the formula was insoluble and in the absence of nitrogenous ingredients produced negative results. In fact it left an impermeable white chemical crust on the fields.⁸³

In their early years the German agricultural experiment stations were by no mean beholden to Liebig, then. They made use of chemistry and professional chemists, but on an ad hoc basis when trying to find answers to specific questions related to arable farming and stock-raising. Only in the late 1850s and 1860s did

⁸¹ For a summary of Liebig's contentions, see Russell, *A History of Agricultural Science*, pp. 98–102.

⁸² *Memoirs and Correspondence of Lyon Playfair, First Lord Playfair of St Andrews* by Wemyss Reid (New York and London, 1899), p. 47, translated letter of 14 August 1841.

⁸³ Finlay, 'Science, Practice and Politics', p. 69.

pure research and *in vitro* experimentation start to take over.⁸⁴ In fact, it is likely that Julius Adolph Stöckhardt the agricultural chemist of the Tharandt station who had helped Crusius to launch the Möckern venture, was the better known and more influential proponent of the science of agriculture in Germany in the middle decade of the nineteenth century. Unlike Liebig, Stöckhardt welcomed contact with farmers and was willing to preach a gospel of progress through a synthesis of field wisdom and experimentally derived knowledge more or less anywhere—even in taverns. He accepted from the outset that practising farmers would not absorb a message extolling the advantages of chemistry which emanated from the mouths of ‘intellectual, domineering, nose-sneering schoolmasters’.⁸⁵ Instead, he deployed clever rhetoric and imagery in his popularization strategy which dwelt upon ‘the giant laboratory of nature’⁸⁶ rather than the institutionalized environment of academic chemists. In 1855 he launched a journal *Der chemische Ackersmann* (*The Chemical Husbandman*), which urged a collaboration of farm and laboratory under the banner ‘*Praxis mit Wissenschaft*’. Its front cover expressed this aspiration in a complex didactic tableau of images and is reproduced in Figure 7.1.⁸⁷

In 1773 the Danish estate owner Caspar Wilhelm von Munthe af Morgenstjerne remarked that husbandry had developed ‘from a thoughtless craft . . . to a cultivated science established on a firm basis’.⁸⁸ Few in Europe would have shared his optimism at that date. Yet a century later arable farming in common with fat-stock-raising for urban meat markets was plainly making huge strides. No longer was the productivity revolution in agriculture confined to the north-western corner of Europe. Perhaps the most important factor driving this process was the manufacture and widespread use of artificial fertilizers: if only for this reason, therefore, it seems proper to conclude that agriculture was becoming an experiential science. Grain growers faced with stiff competition from extra-European producers switched land to new crops such as sugar beet, which accelerated the forces of modernization in large parts of Germany and north-eastern France. While beet

⁸⁴ Jas, *Au Carrefour de la chimie et de l’agriculture*, p. 85.

⁸⁵ Finlay, ‘Science, Practice and Politics’, p. 82.

⁸⁶ Jas, *Au Carrefour de la chimie et de l’agriculture*, pp. 91–2.

⁸⁷ ‘In the center is a rural scene. In the foreground, cattle and sheep are feeding in the comfort of a peaceful autumn day. Farther away a reaper is laying down his sickle by the waving grain to follow the heavy load that is trundling homeward from the field. In another field a plowman has left his plow in the furrow, while he and his tired horses are enjoying a brief period of rest. Close by him are the bags of guano and bone-dust to replace the precious ingredients of plant-food that have been carried away with the harvest. Beyond is the little village, with its steep-roofed cottages, and the village church surrounded by shade-trees and surmounted by a tower whose bell calls the inhabitants to morning work, to vesper rest, and to Sabbath worship. Directly in the front the ground has been cut away, and reveals, in the deep recesses toward which the roots of the trees and herbs are seen to penetrate, a strange laboratory where imps and kobolds are busy with furnace and crucible, retort and mortar, test-tube and balance, as it were, working over materials and concocting the compounds that are to be gathered up by the plants, and make the fruit to reward the tiller of the soil. Between this occult laboratory and the farm-work that is going on above are the words “*Praxis mit Wissenschaft*” (“Practice with Science”), from Wilbur O. Atwater, ‘Sketch of Julius Adolph Stöckhardt’, *The Popular Science Monthly*, 19 (June 1881), 264; also Finlay, ‘Science, Practice and Politics’, p. 93.

⁸⁸ Kjaergaard, *The Danish Revolution*, p. 253.



Figure 7.1. *Practice with Science*

Source: *Der Chemische Ackersmann. Naturkundliches Zeitblatt für deutsche Landwirthe* by Adolph Stöckhardt, volume 1, 1855.

cultivation remained obstinately labour-intensive, it was truly an agent of science inasmuch as it stimulated both mineral fertilizer production and waste recycling, the cattle and dairying industries having discovered that the tops and the pulp provided stock with far more winter nourishment than open pasture. Meanwhile agronomists slowly evolved into chemists and phytologists; they even acknowledged the force of Liebig's critique of experimental methodology, if not always the conclusions he drew from deductive reasoning. Fact grubbing—the very stuff of 'rational', practitioner agriculture—yielded to hypothesis testing both in the field and in the laboratory.

8

Nature and Environment

The ambition to bring order to Europe's landscapes via the rational allocation and use of physical space lay at the heart of Agricultural Enlightenment. By the closing decades of the eighteenth century, moreover, it was drawing strength from a widely held belief that advances in hand-tool and machine technology and in the chemical and geological sciences would provide all the weapons needed in order to conquer and subdue the natural world. 'We war with rude nature;' observed Thomas Carlyle matter-of-factly, 'and, by our resistless engines, come off always victorious, and loaded with spoils'.¹ This chapter will focus on the urge to improve in the spheres of land use and human settlement. It examines the evolution of agrarian landscapes in the period c.1760–1840 and the implications flowing from the reorganization of the land for the social spaces which farmers and rural labourers occupied.

The 'natural environment', it should be emphasized, is a rhetorical construction for Europe's agrarian landscapes were man-made and therefore dynamic and contingent formations, as indeed was much of its topography. Vegetation cover, soil fertility, land use, settlement patterns, and prevailing atmospheric conditions tended to alter over time, even over the relatively short period of time encompassed by this book. So did humans' apprehensions of what constituted 'nature'. In the purest sense of the term 'agriculture' presupposed the taming of the wild²—an activity which for centuries had been an arduous struggle without any guarantee of success. Although temporary or intermittent land use did not altogether cease in the Europe of the eighteenth century, the ideas we associate with the Enlightenment encouraged a new confidence that the constituents of the natural environment could now be put to work on a more regular and permanent basis and managed for the benefit for humanity—providing always that the 'laws' governing their existence had been thoroughly understood.

At one extreme, though, the very disorderliness of the natural world triggered a reflex of retreat into the realms of Cartesian abstraction. This artificial 'nature' apprehended at a distance via the power of reason became a staple of the armchair theorists of Agricultural Enlightenment as we have seen. Yet at the other we find a clear recognition by the century's end of specific attributes or features attaching to 'nature' whether approached from the angle of utility, or that of aesthetics.

¹ Thomas Carlyle, 'Signs of the Times', in *The Edinburgh Review*, 49 (June 1829), 442.

² Robert A. Dodgshon, *Society in Time and Space: A Geographical Perspective on Change* (Cambridge, 1998), p. 108.

Landscape, that is to say, was becoming a potential source of visual enjoyment as well as a resource to be managed and exploited for the common good of humankind. In observers such as Arthur Young whose judgements spanned the cultural watershed separating the Age of Reason from the Romantic era the two responses could be found in combination.³ Young championed enclosure on grounds of agricultural productivity, but while doing so he acknowledged that a neatly hedged landscape conferred infinite pleasure upon the eye. Indeed open-fields, when compared with the composed and harmonious structures of improved farmland, scarcely merited the accolade of a landscape. They were undifferentiated and therefore tedious and tasteless. As for heath and 'waste' which Young would condemn out of hand, for example when traversing Brittany in 1788, it was neither productive nor picturesque.⁴

Perhaps the most palpable expression in the eighteenth century of this developing sense of mastery over nature was the landscape map. Few were compiled before the 1760s which is revealing in itself. Whether or not we agree that map-making should be considered a peculiarly Western form of rationality,⁵ it is evident that neither governments nor agrarian elites in Europe paid very much attention to questions relating to the close definition of territory before this date. With the exception of the Nordic States (Sweden and Denmark-Norway) where attempts to express refashioned landscapes in a visual manner began quite early, most rulers were content with a proximate, non-territorial description of their domains which could usually be conveyed in a narrative format. As has been noted in chapter two the move towards precision in this area was driven very largely by fiscal pressures and it was made possible by technical advances in surveying and map-drawing. Once the mapping of the so-called natural environment had begun there would be no stopping the process for it provided hitherto undreamt-of opportunities for standardization and social control. Maps became formidable instruments of information presentation alongside those other 'statistical' innovations of the age: tables, bar graphs, and pie charts. Not only did they express in a tangible form the growing sense of empowerment vis-à-vis nature, they appeared to control the destinies of whole populations as well.

What the first landscape maps would have revealed towards the middle of the eighteenth century had they been drawn up in any number was an environment heavily impregnated with human activity. From an agricultural point of view the whole of Europe can be divided into three broad zones: regions of bocage, regions of open-field, and Mediterranean regions. Bocage landscapes consisted of a seemingly random distribution of woodland, pasture, and roughly square-shaped arable fields flanked, generally speaking, by tree-lined hedges and connected by sinuous,

³ John Barrell, *The Idea of Landscape and the Sense of Place 1730–1840: An Approach to the Poetry of John Clare* (Cambridge, 1972), pp. 75, 77–8, 81–3.

⁴ *Arthur Young's Travels in France*, 31 August–5 September 1788.

⁵ See Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (Basingstoke, 2007), pp. 60–1.

often sunken paths and lanes. Such landscapes were to be found along the greater part of the Atlantic facade of Europe and also in North-Sea-facing regions running from Norway to Galicia. They could be found a considerable distance inland as well. Lower Normandy (in France) and Devon (in England) are often considered by human geographers to possess all, or most of the key features of a bocage landscape. However, we should treat with some caution the suggestion from an older school of geographers that the bocage must therefore have been ancient in origin and immutable. As human constructs, landscapes were in a constant state of flux and in some cases (Brittany, Schleswig-Holstein, the provinces of the south-eastern Baltic) it is possible to document a transition from open-field to bocage, or indeed vice versa, which had barely been completed by the start of the eighteenth century.⁶

The open-field landscape is usually associated with cereal-based agriculture and its extension northwards and eastwards across the sandy plains of Europe during the post-medieval era. By the eighteenth century such landscapes extended from the north-west of England to the confines of Poland. Unlike the bocage, the open-field environment was literally open, unbroken, and, in the absence of shelter belts of trees, exposed to the elements and the scouring force of the wind at all seasons of the year. While some observers were struck by the grandeur of such vistas, others saw nothing but monotony and an unpleasing uniformity.⁷ The grouped or nucleated village habitat which prevailed on the cereal plains reinforced this impression of uniformity, and so did the system of farming based typically on the collective cultivation of three large fields in rotation which we have described elsewhere in this book. Arthur Young attempted to map the open-field landscape zone as he had encountered it in *ancien régime* France, drawing attention to an irregular quadrilateral of territory stretching from the estuary of the Seine to the banks of the Loire at Orléans, before snaking away east- and south-eastwards in the direction of the Burgundian town of Beaune and the flood plain of the river Saône.⁸

Open fields were farmed communally in a way that the plough land of the bocage region was not. Usually they were divided into long strips which might be as little as ten metres wide yet two hundred metres in length. There were no hedges or fences, merely deep furrows resembling ditches or else boundary stones which demarcated, often rather poorly, one farmer's holding from that of his neighbours. Although it was possible to come across hedged or fenced enclosures in an open-field environment they were rare in proportion to the total land surface under arable cultivation. This, of course, was one of the chief criticisms voiced in contemporary savant discourse on common-field husbandry. Arthur Young who for all his

⁶ See André Guilcher, 'Points de vue nouveaux sur la structure agraire de la Bretagne', *L'Information géographique*, 10:1 (1946), 9–15 and more generally H. Renes, 'Grainlands: The Landscape of Open Fields in a European Perspective', *Landscape History*, 31:2 (2010), 37–70.

⁷ 'Paysage monotone et vide pour les uns, paysage majestueux, voire grandiose pour d'autres', Huguette and Pierre Flatrès, 'Mutations agricoles et transformations des paysages en Europe', *Noréis*, 44 (1997), 174.

⁸ Young, *Travels during the Years 1787, 1788 and 1789*, ii, chapter two and maps.

prejudices and enthusiasms did actually collect a great deal of first-hand data on agrarian landscapes and their soils claimed that a traveller, on emerging from the Sologne (an inland bocage region) and crossing the Loire river at Orléans, would not set eyes on an enclosed cornfield again until he neared the town of Valenciennes close by the Flemish border of the Austrian Netherlands.⁹ It is true that where land had been enclosed in the course of the eighteenth century, it was more usual for it to be planted not with rye or wheat but with leguminous crops such as clover for use as fodder.

For the would-be agriculturalist the Mediterranean region posed challenges that scarcely existed anywhere else in Europe. The supply of fertile and friable flat land capable of sustaining autumn-sown annual crops was often limited which necessitated the terracing of hillsides and other land re-use expedients. Moreover water—the lack of it rather than the clogging moisture that hampered cereal production on the stiff clays of Lorraine or the South Midlands of England—required that close attention be paid to irrigation, for otherwise only tree crops that could tolerate the minimal rainfall of the spring and summer months offered any prospect of a regular harvest. In Provence, for example, this resulted in rather incoherent dry agriculture landscapes in which olives, grapes, fruits, and cereals (wheat and barley) were produced in a patchwork quilt of orchards and fields with much under-planting and relatively little scope for open-field cultivation, or crop rotation. The main ecological alternative was forest and scrub clearance to produce a landscape adapted to pastoralism. This was the option chosen in central and southern Spain where the merino sheep flocks of the Mesta grazed a barren and eroded landscape which had been denuded of trees over many centuries.

Heath and moorland including coastal sand dunes, together with bog and forest made up the other main components of Europe's so-called natural environment at the mid-century point, but whilst these areas doubtless constituted ecosystems in their own right they functioned primarily as adjuncts to the agrarian landscapes already described. Nevertheless, the extent and persistence of heath and 'waste', wetland, and forest should not be underestimated. As David Blackbourn has remarked, 'a German of 1915 or 1940 transported back to 1750 would have been astounded at how different the "natural" landscape looked—much less of it was cultivated, much more of it dominated by sand or scrub and especially by water'.¹⁰ Would the same have been true of a German or maybe a Lorrainer transported back to 1700, or 1650? By the time the Thirty Years' War came to an end in 1648 rural depopulation and habitat destruction had resulted in a significant loss of settled and cultivated landscapes, whether in the Low Countries or in central Europe: farmland had simply reverted to heath and early growth forest. In fact it took nearly a century for the population levels of c.1600 to be restored in Germany and even in 1800 it is unlikely that more than about 56 per cent of land surface

⁹ Peter M. Jones, 'Agriculture' in William Doyle (ed.), *The Oxford History of the Ancien Régime* (Oxford, 2014), p. 241.

¹⁰ Blackbourn, *The Conquest of Nature: Water, Landscape and the Making of Modern Germany*, pp. 1–2.

was under regular modes of cultivation.¹¹ In France, by comparison, the figure was more like 65 per cent and in England 72 per cent.¹²

This raises a question as to the capacity of Europe's agrarian landscapes to support unchecked demographic growth; a relevant question when we bear in mind that net population increase from around 1760 served as the curtain-raiser for Agricultural Enlightenment and as perhaps the main factor propelling the most favoured regions of Europe in the direction of an Agricultural Revolution. Was the agricultural system in rough equilibrium in the second half of the eighteenth century, or was it already pressing against apparently insurmountable ecological constraints?

The anxieties of the classical economists on this score were expressed most clearly by Thomas Malthus at the turn of the century who doubted whether sufficient acreages of 'empty', that is to say, unused or underused land remained in order to feed and maintain Europe's teeming population. Environmental historians, subsequently, have pointed to the cumulative and deleterious effects of centuries of over-cropping and over-grazing, particularly in fragile or marginal environments such as the coastal heaths of Jutland, the sheep-runs of Andalusia, or the Corbières hills of south-west France: deforestation, soil erosion, sand drift, nitrogen depletion, acidification, modifications to the water table, and so on. The burning of moorland or the ploughing up of natural grassland might provide a stay of execution, but the long-term loss of minerals was not easily reversed by the technology available to early nineteenth-century cultivators—even supposing that the causes of soil deterioration were fully understood. Part of the attraction to German farmers of Justus Liebig's 'chemistry of agriculture' lay in the fact that it seemed to offer a quick and pain-free means of restoring the vitality of the soil without resorting to fallowing or grass leys.

Some of these ecological arguments have been taken up by global historians and woven into their interpretations of the differential development of the West and the East.¹³ They question the capacity of European agriculture to develop beyond the productivity thresholds achieved by 1750 and suggest that the land supply had also become inelastic by the century's end, thus necessitating the acquisition of territory overseas on which to grow food and industrial crops. Yet there seems to be no good reason to suppose that this was the case. The 'extensification' of agriculture had not yet run its course in 1800: the attractive 'pull' of the west European grain market remained strong and German and other colonists were busily laying out open-fields for cereal cultivation in the empty spaces of New Russia even as Agricultural Enlightenment reached its peak. Intensification, moreover, was waiting in the wings. As we shall see, the capacity of Europeans to reclaim land from heath, moor, and marsh and to convert existing pasture and arable to new productive uses was not yet exhausted.

¹¹ Heide Wunder, 'Agriculture and Agrarian Society', in Sheilagh Ogilvie (ed.), *Germany: A New Social and Economic History*, vol. 2: 1630–1800 (London, 1996), p. 63.

¹² Chevet, *La Terre et les paysans en France et en Grande-Bretagne*, i, p. 16 Table I.

¹³ See in particular Kenneth Pomeranz, *The Great Divergence*.

LANDSCAPE AND LAND USE

The usual expedient when population growth began to exert pressure on resources, or when the development of consumer markets started to offer new opportunities was to bring more land into regular cultivation and to adapt existing land use to meet the change in conditions. We find both of these processes taking place informally at the level of the manor, the village, and the individual farm from the 1760s onwards. However, there is strong evidence to indicate that governments also intervened to promote land reclamation without waiting for pressure to build from 'below'. More often than not the impetus for such intervention was fiscal as we have observed, but the ambition to improve and rationalize agricultural landscapes was also present in the thinking of bureaucrats. Land clearing at the expense of heath and pasture had been widely practised in the sixteenth-century Europe and has been thoroughly documented in, for instance, the Duchy of Württemberg.¹⁴ However, in the mid eighteenth century it is the sustained involvement of the State in such enterprises which attracts our attention. In Denmark-Norway the emergence of Count Adam Gottlob Moltke as Lord Chamberlain following the accession of Frederick V in 1746 marked a turning point. It resulted in a royal edict of 1751 ordering a start to be made on the reclamation of the heaths of Alheden in western Jutland. In Prussia all heath and moorland was taken into public ownership by Frederick II in 1765, whilst in France measures intended to encourage the clearing of supposedly unproductive land were issued in 1761 and again in 1766.

In the Jutland peninsula barely two-fifths of the soil was subject to arable cultivation which made the province a prime candidate for agricultural improvement in the eyes of State officials.¹⁵ However, the challenge was considerable since centuries of deforestation had resulted in the creation of permanent heaths which in the West, moreover, were vulnerable to drifting sand. Sand movement in this region was a perennial, climate-driven phenomenon and one which seems to have reached a secular peak of intensity in the period 1680–1750. By the end of the eighteenth century the all-invading sand had totally obliterated the old landscape in several districts and prompted the removal of a number of coastal settlements to new sites further inland.¹⁶ It hugely complicated the task of bringing about a durable agricultural improvement. Government interventionism, beginning in the 1750s, adopted a three-pronged approach: dune planting, colonization, and steps to reduce acidification and restore the nutrient balance of the soil. The planting of the dunes with marram grass and conifers only began in earnest in 1792. Success in this endeavour came very slowly since the policy required a great deal of experimentation with different species of pine and not a little political determination.

¹⁴ Paul Warde, *Ecology, Economy and State Formation in Early Modern Germany* (Cambridge, 2006), pp. 224–79 and *passim*.

¹⁵ Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark*, p. 7.

¹⁶ Daniel C. Knudsen and Charles E. Greer, 'Heritage Tourism, Heritage Landscapes and Wilderness Preservation: The Case of National Park Thy', *Journal of Heritage Tourism*, 3:1 (2008), 25.

Nevertheless, by 1827 French agronomists would freely acknowledge that Denmark was the only country in Europe to have managed to stabilize loose, sandy soils.¹⁷

Schemes to attract settlers possessing heath-clearing and cultivation skills were put in train very swiftly by contrast. They formed part of the Europe-wide effort to colonize under-populated regions with able husbandmen which was outlined in chapter five. The first Alheden colonists came from the progressive Pfalz (Palatinate) farming region of south-western Germany. They were offered exemption from church tithes, from taxes and military conscription for twenty years, and it appears that up to three hundred families joined in the trek to Jutland, partly in order to escape the devastation wreaked by the Seven Years' War. By 1763, they had managed to set up six nucleated settlements in the heath which in their appearance and layout resembled the villages they were familiar with in the Rhineland-Palatinate. As the removal of the heath proceeded, they clearly intended to practise a form of communal open-field agriculture based on strip farming. This, despite the fact that the Danish authorities wished to have the heath landscape replaced with compact holdings in which farmsteads would be located in the midst of the fields rather than grouped in villages—in other words the model that would become the basis for the Statist agrarian reforms of the 1780s and 1790s.

The indigenous heathland peasantry were not very impressed with the efforts of the colonists, and it is true that many of the newcomers swiftly moved on—in some cases to join German colonies along the Volga (see p. 114). Until extensive marling became feasible in the second half of the nineteenth century, 'slash and burn' cultivation of plots hacked out of the heath appears to have been the only viable way of exploiting the Alheden. Eventually the Pfalz colonists came to realize this: they adopted the custom of clearing and burning in the autumn followed by the ploughing in of ash deposits over the winter. Then, in the spring, field crops (rye, oats, buckwheat, or potatoes) would be planted. However, the ash benefit to the crops was brief for the soil remained highly acidic, making long fallowing unavoidable. In such conditions open-fields and regular rotations were quite unrealistic and we know that in practice the farmer-colonists simply cleared individualized fields in the surrounding expanse of moorland for temporary cultivation. Danish peasants called their new neighbours *Kartoffeltyskerne* or 'Potato Germans', in reference to the main dietary innovation they had brought with them to Jutland.¹⁸

Moor burning in order to colonize uncultivated 'waste' land was resorted to on a large scale in Brandenburg in this period as well. The potash allowed crops of buckwheat to be grown for perhaps four or five years and a type of flour produced from which pancakes could be made. However, the most determined reclamation efforts undertaken by the Prussian State were concentrated on wetlands and fens

¹⁷ *Bulletin des sciences agricoles et économiques*, 7 (1827), 22.

¹⁸ For this paragraph see Harry Thorpe, 'A Special Case of Heath Reclamation in the Alheden District of Jutland, 1700–1955', *Transactions and Papers (Institute of British Geographers)*, 23 (1957), 87–121; Niels Windfeld Lund 'Kartoffeltyskerne: Livsvilkår i de jyske hedekolonier i det 18 årh. / The Potato Germans: Living Conditions in the Jutland Heath Colonies in the 18th Century', *Folk og Kultur*, (1975), 31–66. Also <http://Kartoffeltysker.dk> (accessed 10 September 2014).

that covered large stretches of the north German plain. Between 1747 and 1753 the Lower Oderbruch was drained and the bed of the meandering Oder river rerouted. As a result an area on either side of the river about sixty kilometres long and between twelve and twenty kilometres wide was made available for cultivation. Neatly laid-out fields bisected by drainage ditches replaced the marsh environment. The manor of Möglin where Daniel Albrecht Thaer established his model farm and teaching institute bordered this zone and it was augmented with land in the Oderbruch proper which Thaer rented on a long lease. Similar schemes would be carried out near Stettin and in the valleys of the Netz and the Warthe, while in the late 1770s over 90,000 hectares of land was reclaimed from the Drömling marsh in Altmark. All of these hydraulic projects required a combination of practical skills and scientific expertise. They can be considered state-of-the-art products of the Enlightenment knowledge economy.¹⁹

France followed suit albeit with less immediate and visible success. In 1761 Controller General Bertin exempted freshly cleared land from liability to pay the *taille* and *capitation* taxes for a period of ten years. These exemptions were made more attractive and their scope widened in 1766, the aim being to increase volume production by means of agricultural extensification. Whether this objective was actually achieved is difficult to judge. Several contemporary observers considered that French farmers already had more land under the plough than they could adequately prepare for crops, given the quantities of animal dung available to them. Yet if we are to believe reports filed at the time, an additional 600,000 hectares of land were brought into cultivation between 1766 and 1789.²⁰ Most of this increase to the arable stock would have been rather poor-quality land though, and in any case it constituted only a tiny fraction of the heath and 'waste' land in existence at the end of the *ancien régime*. In 1790 there were over 323,000 hectares of un-cleared land in the *généralité* of Châlons alone.²¹

The really significant progress made in opening up new land in France was achieved during the Revolution of 1789 and its aftermath when the 'productivist' agenda inherited from the physiocrats was reinforced by political pressure to facilitate access to the soil for the poor and the dispossessed.²² Land clearance became a veritable frenzy and by the time of the Bourbon Restoration in 1814–15 it was producing a chorus of complaint: from bureaucrats, from graziers, and from large estate owners bemoaning the loss of a docile pool of agricultural day labourers. The prefect of the mountainous Lozère department where *défrichement* threatened to cause permanent damage to unstable hillsides condemned these ill-advised altera-

¹⁹ Blackbourn, *The Conquest of Nature*, pp. 26–40.

²⁰ Becchia, *Modernités de l'Ancien Régime*, p. 69.

²¹ Bourde, *Agronomie et agronomes*, iii, p. 1442.

²² In 1791 Broussonet, perpetual secretary of the Society of Agriculture of Paris, remarked, 'cette année, on a défriché et mis en culture plus de terre que pendant les dix années qui ont précédé notre génération... Le sol de la France est fertilisé par l'engrais de la liberté', cited in Boulaine, *Histoire de l'agronomie en France*, p. 231.

tions to the agricultural landscape as 'an epidemic born of revolutionary principles which it will be very difficult to root out by the usual means'.²³

Although the pre-Revolutionary government of France had also joined in the assault on wetlands with a measure in 1764 to promote the draining of marshes, little seems to have been achieved in the short term. It has been argued that the late Bourbon monarchy, unlike the nascent absolutist Prussia of Frederick II, lacked the political muscle to override vested interests standing in the way of the public good.²⁴ Only once the Revolution had simplified and unified the institutional structures of the country could irrigation or wetland reclamation projects go ahead. This scenario is plausible even if it still remains to be demonstrated in convincing detail. For whatever reason, very few major drainage projects were brought to a successful conclusion in France during the eighteenth century. On the other hand, a study of water control and land reclamation in Provence shows that most of the progress achieved in the construction of irrigation canals to distribute water from the Durance river occurred in the period between 1820 and 1860.²⁵ It is certainly true that the pace of land reclamation from heath in France accelerated dramatically in the decades after the Revolution. The heaths of Brittany were cleared and ploughed up in a very short space of time in the 1850s, and by 1862 the total area of 'waste' land in France appears to have dropped by around 30 per cent (from 8.5 million to 5.9 million hectares) compared with the surfaces recorded as such in the *Enquête agricole* of 1836.²⁶

Land reclamation in Scotland, England, and Wales relied more on the commitment and resources of improving landlords than the interventionism of the State as we might expect. Thus the Scottish peer Henry Campbell Scott, the third Duke of Buccleuch, spent a small fortune draining Eckford Moss in Roxburghshire in order to gain access to its marl deposits.²⁷ In England, perhaps 405,000 hectares were recovered in this fashion during the eighteenth century which probably augmented the existing stock of plough land by around 5 per cent.²⁸ Reclamation proceeded much more swiftly in the nineteenth century with a drop in the acreage of 'waste' in England and Wales of about a third between c.1800 and 1873.²⁹ The removal of excess water from the land made slower headway, however. It waited upon advances in the technology of hollow- or under-drainage: tile drains in the 1820s and then glazed pipe drains a couple of decades later. Investment in under-drainage made eminent sense on clay soils, but for most farmers it represented a considerable financial outlay which only returned a profit over a number

²³ Peter M. Jones, 'Common Rights and Agrarian Individualism in the Southern Massif Central 1750–1880', in Gwynne Lewis and Colin Lucas (eds), *Beyond the Terror: Essays in French Regional and Social History, 1794–1815* (Cambridge, 1983), p. 130.

²⁴ Rosenthal, *The Fruits of Revolution: Property Rights, Litigation and French Agriculture*.

²⁵ Rosenthal, *The Fruits of Revolution*, p. 120.

²⁶ Hugh D. Clout, *The Land of France 1815–1914* (London, 1983), pp. 46–51 and Table 4.2.

²⁷ Bonnyman, 'Agricultural Improvement in the Scottish Enlightenment', p. 130.

²⁸ Chevet, *La Terre et les paysans en France et en Grande-Bretagne*, i, p. 16.

²⁹ See Michael Williams, 'The Enclosure and Reclamation of Waste Land in England and Wales in the Eighteenth and Nineteenth Centuries', *Transactions of the Institute of British Geographers*, 51 (Nov. 1970), 59–62.

of years. In the later 1840s the British government began to offer loans in a bid to encourage the adoption of this improvement. In Ireland, by contrast, it was population pressure and rising rents which incited peasant plot-farmers to drain acidic mountain bogs so as to create small fields in which potatoes could be grown. The overall scale of land reclamation during the war years (1793–1815) and again in the 1830s and 1840s is unknown, although significant county-level increases in crop-bearing ground are recorded.³⁰

Clearance in Scandinavian countries often impinged upon the forest as well as the heaths and natural meadows. Whilst the total area subject to arable cultivation in western Europe probably doubled between 1700 and 1870, in Sweden it tripled in part because of felling and burning.³¹ This increase was well in excess of the country's population growth, with the result that Sweden not only became self-sufficient in agricultural products in the 1820s but a net exporter of foodstuffs. Traditionally forests were used for the summer grazing of livestock in the northerly and high-altitude regions of Europe where all the available hay-meadowland had to be reserved for winter fodder production. Forests had always been a theatre of tensions over land use; tensions that were magnified in the late eighteenth century by the cameralists' insistence that land bearing trees be treated as a unit of production in its own right.

Forest cover had dwindled to the point of insignificance in England and also in Ireland in the course of the seventeenth century but in Germany, the birthplace of 'rational' arboriculture, woods covered roughly a quarter of the land surface in 1800. As such they provided fuel, grazing for sheep, goats, and pigs and a wilderness realm for the huntsman. The efforts of foresters to turn these assets into a timber resource via the scientific management of tree species and a rolling programme of selective felling and replanting clashed with all of these age-old uses. In the case of France the forest cover had suffered badly during the Revolution, dropping by two-thirds over thirty years according to one estimate although this fraction seems implausibly high.³² At any event, when State authority was reasserted in the 1820s a series of 'forest wars' broke out as peasant agro-pastoralists in the Pyrenees challenged local officials and gendarmes who tried to prevent them from driving their flocks into mountain forests.³³ The immediate context for these clashes was the restored Bourbon government's determination to take back control of the tree-scape from communities of users by means of a new Forest Code. Similar confrontations occurred in the Massif Central when, in the 1840s, forestry

³⁰ Ken H. Connell, 'The Colonisation of Waste Land in Ireland, 1780–1845', *The Economic History Review*, 3:1 (1950), 44–71.

³¹ Gadd, 'The Agricultural Revolution in Sweden, 1700–1870', in Myrdal and Morell (eds), *The Agrarian History of Sweden*, pp. 156–8.

³² See Roger L. Williams, *Botanophilia in Eighteenth-Century France: The Spirit of the Enlightenment* (Dordrecht, 2001), p. 172.

³³ John M. Merriman, 'The "Damoiselles" of the Ariège, 1829–1831', in John Merriman (ed.), *1830 in France* (New York, 1975), pp. 87–118. For comparable 'forest wars' in Germany, see Uwe E. Schmidt, *Der Wald in Deutschland im 18. und 19. Jahrhundert. Das problem der Ressourcenknappheit dargestellt am Beispiel der Walddressourcenknappheit im 18. und 19. Jahrhundert: eine historische-politische Analyse* (Saarbrücken, 2002), pp. 119–25, 165–71, 200–9.

officials started to replant the largely denuded slopes of Mont Lozère, the Margeride, and the Cévennes. Here the tree cover had been progressively thinned out in order to create grass pastures for transhumant flocks arriving from Languedoc to spend the fine season in the mountains. There were 100,000 transhumant sheep pasturing on Mont Lozère alone during the summer of 1845. Without their dung a biennial cycle of cereal agriculture (rye/fallow) on the thin, acid soil was barely viable, leaving intermittent 'slash and burn' cultivation as the only alternative.³⁴

Opening up new land was costly and liable to diminishing returns. It often made better economic sense to reorganize the existing arable surface, or to use it for different, more innovative purposes. The long strips characteristic of traditional open-field agriculture could be refashioned to produce a variant of convertible husbandry. This, in essence, is what the practice of *Koppelwirtschaft* amounted to. In the 1770s the demesne tenants of the Giesegaard estate situated on the island of Zealand about forty miles from Copenhagen debated whether to give up the three-field system altogether, modify it by increasing the number of fields in the rotation to between four and six, or switch to a Holstein system involving ten *Kobler* (individually owned fields) which would allow much longer periods of fallow. They opted for the latter, but the transition took a number of years to complete and proved extremely labour-intensive since it required the ploughing out of the old ridge and furrow and a great deal of fencing.³⁵ Needless to say, the demesne farm landscape was utterly transformed in the process. In Scotland, by contrast, the first step on the path to improvement through land reorganization usually involved modifications to the infield–outfield system which prescribed the pattern of cultivation of the rigs or strips. Where farmland was held in 'ferm touns', a simplification of tenurial relationships took place with the result that disparate holdings underwent a degree of consolidation. This often necessitated the construction of new access roads and therefore a substantial reordering of the landscape.³⁶ Similar forces were at work in Ireland and they resulted in the introduction to the landscape of planned estate villages. The consolidation of diminutive farmholdings occurred later and was driven mainly by the shift away from an economy based on tillage to one based on grass in the aftermath of the Napoleonic Wars.³⁷

Quite apart from their hostility to the onerous collective obligations that were integral to open-field agriculture, 'enlightened' commentators shared in the view that long and thin strips of plough-land were not an efficient format within which to cultivate cereals, or indeed any other crop. Agrarian historians have measured ridges running up to four, even five hundred metres in western Lorraine.³⁸ On the flat lands of Burgundy in the middle of the eighteenth century 78.3 per cent of the

³⁴ Roger de Saboulin-Bollena, 'Les Forêts de la Lozère', *Forêt méditerranéenne*, 5:1 (1983), 14.

³⁵ Palle O. Christiansen, *A Manorial World: Lords, Peasants and Cultural Distinctions on a Danish Estate, 1750–1980* (Oslo, Copenhagen, Stockholm, Oxford, and Boston, MA, 1996), pp. 269–72, 323–6.

³⁶ For an example of this process, see George Kay, 'The Landscape of Improvement: A Case Study of Agricultural Change in North East Scotland', *Scottish Geographical Magazine*, 78:2 (1962), 100–11.

³⁷ Raymond D. Crotty, *Irish Agricultural Production: Its Volume and Structure* (Cork, 1966), p. 37.

³⁸ Reitel, 'A Propos de l'openfield lorrain', 46.

strips forming the agricultural territory of the village of Saint Nicolas-les-Cîteaux were longer than 250 metres and 45.7 per cent longer than 300 metres. Moreover, nearly half (47.8 per cent) had a width of less than twenty-five metres.³⁹ The enclosure of land owned and farmed in this fashion was out of the question, which is why virtually all of the proposals for structural reform mooted during the period of Agricultural Enlightenment presupposed very considerable alterations to existing landscapes.

Not everyone agreed that tree-lined hedges, banks, wattle fences, or dry-stone walls constituted an improvement, though. In a written response to the commissioners of the 1866–67 *Enquête agricole* a Burgundian landowner who farmed at the south-eastern limit of France's open-field zone asserted as if it were a matter of common knowledge that 'hedges deprive plants of the invigorating action of the air and the sun and provide a refuge for animal pests'. It is true that hedges occupied space and trees cast shade and might also suck up moisture from the soil, or else impede winter drainage. In the judgement of many farmers they only made sense in a context of altered land use and systematic enclosure; in other words when physical barriers were required either to confine stock or to prevent infiltration by village herds. Yet long and often sinuous ridges wasted space as well since they inevitably terminated in a barren balk or a headland on which plough teams were turned. Moreover, hedges and field stands of trees helped to break the wind, fix the soil, and reduce evaporation. When in 1820 Baron Dezydery Chłapowski returned to his 17,000-hectare estate at Turew in Poland brimming over with innovative farming ideas he had learned in Britain, he introduced hedges and shelter belts of trees in order to halt soil erosion. In effect, he established a loosely meshed bocage landscape in the midst of the open-fields of western Poland.⁴⁰

The optimal agricultural landscape was hypothesized by the German agronomist and economist Johann Heinrich von Thünen who had studied under both Caspar Voght at Gross-Flottbek and Albrecht Daniel Thaer at Celle. His book *Der isolierte Staat*, the first volume of which appeared in 1826, claimed to have uncovered the principles governing the spatial distribution of field systems. He was therefore very much a product of the 'rational agriculture' generation whose writings he had imbibed at the University of Göttingen and elsewhere. J. H. von Thünen's insight, which he developed both mathematically and experimentally on an estate in Mecklenburg acquired in 1810, concerned the likely impact of transportation costs on land use. He argued that the cost of carrying agricultural goods to market determined both the location and the intensity with which a crop would be grown by farmers, allowing always for factors such as durability, volume, and weight. Thus perishable commodities (dairy products, vegetables, fruit, etc.) should be grown as close as possible to the locus of consumption. Although land-use costs were higher, transportation costs would be lower. On the other hand,

³⁹ Jean Chiffre, 'Métrologie et parcellaire en Bourgogne au XVIII^e siècle', *Cahiers de métrologie*, 4 (1986), 10.

⁴⁰ Konieczna, 'The Influence of the British Pattern on the Agricultural Work of Dezydery Chłapowski'. Since 1992 the Turew estate has been designated the Chłapowski Agro-Ecological Landscape Park.

commodities whose ultimate value depended much less on distance and the cost of transportation (field crops, livestock, etc.) should be produced, by any rational calculation, in more distant locations. This enabled him to construct a theoretical landscape based on concentric rings of land use radiating out from a central marketplace.

Although J. H von Thünen's attempt to model the behaviour of farmers producing raw materials and foodstuffs for sale makes a lot of assumptions (about topography, soil fertility, habitat, and transportation technologies), a number of economic historians consider that it can help us to understand decisions regarding land use in specific settings. In the early modern Netherlands, for instance, many different types of agriculture were practised within a relatively confined area of land and Jan Bieleman⁴¹ argues that von Thünen's emphasis on the transportation cost factor in bringing crops to market does indeed provide an explanation of decisions taken about what to grow and where. He points to the way in which the inter-regional agro-economy of north-west Europe evolved from the sixteenth century onwards which seems to match the spatial logic of von Thünen's theory. Moreover, he cites contemporary evidence suggesting that Dutch farmers were very well aware of the cost implications of transporting grain overland to market towns as opposed to shipping it cheaply from the Baltic.

In truth the conversion of land from one use to another was going on all the time in Europe whether the population was expanding or contracting and, lest we forget, in response to fluctuations in demand from urban consumers both domestic and foreign. The acreage of cultivated ground in post-Famine Ireland contracted by nearly half between 1851 and 1911 as sheep and cattle replaced corn and potatoes.⁴² In a country such as France where the fear of famine remained a constant of life in the eighteenth century the switching of arable land to viticulture often generated dismay and anxiety. In 1774 the sub-delegate of Arbois in the Franche-Comté complained to his superior about the planting of vines on the arable of the locality—a dangerous practice, he observed, should a subsistence crisis on the scale of that of 1771–2 occur again.⁴³

More intensive use of the fallow was perhaps the most obvious response to the build-up of population pressure or, in the vicinity of large towns, to market opportunity. Notwithstanding the unrelenting attrition of the theorists of Agricultural Enlightenment, bare fallows could be found in virtually every corner of Europe still in the middle of the nineteenth century.⁴⁴ Evidence, perhaps, of the abiding backwardness of land-use technologies in the West compared with the East where up to three harvests of rice could be taken from the land in a single year. But

⁴¹ Bieleman, *Five Centuries of Farming*, pp. 26–8.

⁴² Jim Gilligan, *Graziers and Grasslands: Portrait of a Rural Meath Community, 1854–1914* (Dublin, 1998), p. 20.

⁴³ Colette Brossault, *Les Intendants de Franche-Comté, 1674–1790* (Paris, 1999), p. 128.

⁴⁴ Léonce de Lavergne reckoned the fallow in the British Isles at half a million hectares and in France 5 million *hectares*, making 4.5% and 16.7% of the surfaces subject to arable agriculture respectively, see *The Rural Economy of England, Scotland, and Ireland by Léonce de Lavergne; translated from the French with Notes by a Scottish Farmer* (Edinburgh, 1855), pp. 52–3.

equally it was a sign that Europe was not about to run out of territory on which to grow food as an Industrial Revolution beckoned.

Slow-motion land conversion which scarcely registered at the level of a single human lifespan should not be overlooked either. The shifting boundary of forest and heath is a case in point, as is the expansion and contraction of horticultural plots, hemp and flax beds, and the belt of gardens ringing villages and small towns. In Lower Normandy the growth of a long-distance fat-stock industry linked to the Paris market for butchery meat gradually resulted in the withdrawal of fields from cereal cultivation and the creation of a permanent grassy corridor along which the herds being driven towards the capital could be rested, watered, and fattened. On the acidic soils of the southern Cévennes, communities met the challenge of population growth by planting the hillsides with sweet chestnut, known locally as '*l'arbre à pain*'. Here the transformation of the landscape appears to have begun in the late fifteenth century with slopes previously used solely for rye and vines being dotted with chestnut trees. These orchards thickened up in the sixteenth and seventeenth centuries, crowding out all other types of cultivation. By the eighteenth and nineteenth centuries the familiar landscape of chestnut monoculture was firmly established. A well-maintained chestnut orchard yielded between 18 and 20 *quintaux* of fruits per hectare compared with 5 *quintaux* at best for a similar area under rye. The calorific yield of the latter, moreover, represented only a third to a half of that of the chestnut harvest.⁴⁵

The cultivated sweet chestnut (*castanea sativa*) was a fruit-bearing tree which in all probability came to southern France with the Romans. In upland regions where schist and granite soils predominated it supplied the immediate carbohydrate needs of a population whose capacity for growth on the basis of cereal agriculture and viticulture alone was limited. The wonder crops which would help to prepare the way for Europe's nineteenth-century agricultural take-off, however, were legumes operating in tandem with the potato and root vegetables. Legumes, as agricultural scientists eventually came to realize, possessed the very nearly unique ability to fix nitrogen from the atmosphere and when they were harvested and died their entire remaining store of nitrogen was released back into the soil. By the 1880s leguminous crops (clover, sainfoin, lucerne, lupins, pulses, etc.) were being planted all over northern Europe with perhaps a fifth of the arable landscape being allocated to them at any one time.⁴⁶ Yet we should bear in mind that the planting of new crops on old grain land was no straightforward matter: it proceeded by trial, error, and not a little political upset. In the case of the French chemist and experimental farmer Antoine Lavoisier, it took him nearly three years to establish that his land at Fréchines was better suited to sainfoin than to lucerne.⁴⁷

⁴⁵ Jean-Robert Pitte, 'Les Origines et l'évolution de la châtaigneraie vivaraise à travers un document cadastral du XVIII^e siècle', *Comité des travaux historiques et scientifiques, Bulletin de la section de géographie*, 82 (1975-77), 165-78 and Figure 2.

⁴⁶ G. Patrick H. Chorley, 'The Agricultural Revolution in Northern Europe, 1750-1850: Nitrogen, Legumes and Crop Productivity', *Economic History Review*, 34:1 (1981), 71.

⁴⁷ Douglas McKie, *Antoine Lavoisier, Scientist, Economist, Social Reformer* (London, 1952), pp. 154-5.

Whereas the switching of grain land to wine or fodder production would be anathematized for ideological reasons during the Revolution in France, the potato encountered a much deeper cultural resistance as we have seen. In the eighteenth century potatoes appear to have been grown for human consumption on the Continent chiefly in times of acute climatic or political abnormality. For example, the trial field plantings during the droughts of the 1780s, the dearths of the 1770s and 1790s, and during the periods of prolonged economic dislocation caused by warfare between 1756 and 1763 and 1792 and 1814. Yet we know that its cultivation accelerated dramatically in the first half of the nineteenth century. It was as though the breakneck speed of Europe's population growth had finally swept away all remaining dietary taboos. In the (future) kingdom of Belgium the area planted with potatoes increased by 58 per cent (to 120,093 hectares) between 1812 and 1846. By the middle of the century, therefore, roughly one arable hectare in nine was carrying a crop of potatoes.⁴⁸ In the Belgian context the logic of productivity in an agricultural sector which was chasing, yet failing to keep up with population growth seemed ineluctable: a field planted with potato tubers offered about twice the nutritional benefit of a field planted with bread grains.

However it was in Ireland that the consequences of over-reliance on the potato as a human food crop would be displayed in full. Intensive cultivation of the tuber had a long history in this country and its singular importance to the rural economy was recognized as early as 1780. Smallholders became dependent on the crop as their main source of carbohydrates, whilst larger farmers often planted potatoes as a means of preparing the soil for their cereal sowings. A tillage landscape resembling a patchwork of arable fields bearing potatoes, wheat, barley, and oats was the net result, and it is probable that by the start of the nineteenth century the potato formed part of the diet of a very large number of Irish country dwellers and had become the one and only food source of rural labourers and plot-farmers. The headlong expansion of the population at a rate approaching 2 per cent a year by the 1780s was not unconnected to this development. Although the pace of growth began to slow in the 1820s and would eventually peak in 1845, Irish agriculture on the eve of the Famine was required to feed four times as many people as it had done a century earlier. By 1845 about 11 per cent of the country's farmland had been put under potato cultivation or about one arable hectare in eleven.⁴⁹

THE HUMAN HABITAT

Landscapes were also social spaces. Country dwellers must have been aware that the speed of the changes going on around them was accelerating in the second half of the eighteenth century: the anti-enclosure sentiments expressed by the

⁴⁸ Goossens, *The Economic Development of Belgian Agriculture*, pp. 66–8.

⁴⁹ There is some disagreement among the historians of Ireland regarding the scale of potato cultivation prior to the back-to-back harvest failures of 1845–48, see Crotty, *Irish Agricultural Production*, appendix note III and M. Turner, *After the Famine: Irish Agriculture, 1850–1914* (Cambridge, 1996), p. 21.

Northamptonshire 'peasant poet' John Clare are a case in point.⁵⁰ Whether they possessed an ecological consciousness rooted in endogenous knowledge of resource flows in and out of the village community is another matter, though. It seems unlikely that anything resembling modern notions of soil fertility and how to manage it could have existed among the great mass of those who worked and tried to live off the land in these decades. The anarchic clearing of 'waste' and common land by the rural poor which greeted the Revolution of 1789 in France scarcely indicates a preoccupation with the environment. Yet as Paul Warde⁵¹ remarks, disputes over resource use which ended up in litigation do occasionally provide a glimpse of what ordinary people must have thought about the fundamentals of their livelihood and the changes that were threatening to undermine them. When several inhabitants of Le Villaret d'Apchier in the highlands of the Massif Central requested the partition of the village's common pastures in 1868, they received a sharp rebuke couched in multi-generational terms: where would the petitioners be now if their forebears had decided to invoke their 'right' to seek an egalitarian division of these assets when empowered to do so by the Revolutionary *partage* law of 1793? The rebuke to the petitioners was delivered by municipal councillors, which of course begs a question as to whose voice we are actually hearing.⁵²

Yet we *do* hear the peasant voice as governments weighed the pros and cons of land reform and whether to proceed towards the radical restructuring of habitats that systematic enclosure normally presupposed. Not all farmers wanted to have their dispersed strips consolidated into individualized fields on a nebulous promise of enhanced productivity and labour efficiency. 'Un champ', remarked Marc Bloch, 'est, au fond, une œuvre humaine qui s'est constitué de génération en génération'⁵³ and one, moreover, that often carried considerable emotional baggage. As France pondered the wisdom of introducing a nationwide law to instigate farm consolidation on the morrow of the Great War, the *conseil-général* of the Charente *département* noted that such a measure would be resisted by those who were unwilling to give up parcels of land cultivated by their ancestors. The dispersion of strips often had an ecological or economic 'logic' in any case. In some instances it compensated for soil variability; in others it allowed every farmer to have access to land on the plateau or hillside as well as on the plain. Alpine agriculture was predicated on the distribution of fields at different altitudes, while the fruit and vegetable growers of England's Vale of Evesham valued fragmentation as a strategy to limit the danger that frost might blight their crops.⁵⁴

⁵⁰ Barrell, *The Idea of Landscape*, chapter three.

⁵¹ Warde, *Ecology, Economy and State Formation*, p. 321.

⁵² 'l'on peut se demander ici où en seraient plusieurs familles si les anciennes ne consultant que leur seul intérêt avaient largement profité des lois qui à une certaine époque avaient autorisé le partage ou la vente des communaux qui nourrissent tant de bêtes bovines et ovines et d'où l'on retire par des défriches, céréales et pommes de terre', cited in Jones, 'Common Rights and Agrarian Individualism', Lewis and Lucas (eds), *Beyond the Terror*, pp. 135–6 and note 58.

⁵³ Marc Bloch, *Les Caractères originaux de l'histoire rurale française*. 2 vols. (Paris, 1952, 1956), ii, p. 216.

⁵⁴ See *The Consolidation of Fragmented Agricultural Holdings: An FAO Study Prepared by Sir Bernard O. Binns* (Washington, 1950), pp. 5–6, 90.

However, the logic of experience rooted in a mentality of risk avoidance, short-range commodity exchange, and exceedingly low levels of productivity was not the logic of the rural geometricians of Agricultural Enlightenment. When Rutger Macklean ordered the first modern agrarian landscape in Sweden to be laid out at Svaneholm, it was intended as a beacon of modernity. The map of the new landscape drawn up by his surveyor in 1785 depicted every farm situated in the middle of a square or rectangular landholding with all borders and access tracks following straight lines.⁵⁵ The big casualty in this rearrangement which prefigured changes that would take place throughout the province of Scania within a few decades was the sense of community; in other words the social space of the village with its grouped farmhouses and central green. Modernity appeared to preclude sociability. It banished, too, the promiscuity of intermingled stock and the culture of neighbourly hob-nobbing as farmers moved back and forth between their scattered holdings.

The solution to fragmentation and dispersion in the judgement of late eighteenth-century reformers lay in the bringing together or consolidation of holdings (*réunion* or *remembrement* in French; *Vereinödung* or *Güterzusammenlegung* in German). If the fragmented and scattered plough- and meadowland of the communal systems of agriculture prevailing across much of northern and central Europe could somehow be reallocated so that each tenant or owner-exploiter resided in the midst of a compact block of workable ground which he—and he alone—had access to, manifold advantages would surely flow. Collective rights such as village stock grazing and stubble gleaning would lose their *raison d'être*; land could be enclosed and improved; new crops and rotations tried out and labour productivity and maybe even harvest yields would rise as a consequence. Moreover, if partition of the communal pastures of the village or manor were included in the reform, the last remaining link to communal forms of husbandry could be severed.

Even if the strategists of Agricultural Enlightenment exaggerated the scale of the problem when pursuing their vision of the rectilinear agrarian landscape and exaggerated, too, the benefits that were likely to accrue from structural reform, there can be no doubt that farmland fragmentation was increasing in a number of regions of Europe under the impact of sustained demographic growth. This was particularly true in the provinces of Lorraine and Alsace where in 1771 the Academy of Metz announced a prize essay competition on the theme of 'la désunion des diverses portions d'héritages possédés par un même propriétaire sur un même ban ou finage'⁵⁶ and how to remedy it. As the debate got under way in France extreme examples of the fragmentation that was so characteristic of the

⁵⁵ See Germundsson, 'Landscape and Modernity', in Sundberg et al. (eds), *Modernisation and Tradition*, p. 205, Figure 2; also Henrik Svensson, *Öppna och slutna rum—enskiftet och utsattas geografi: husmän, bönder och gods på den skånska landsbygden under 1800-talets första hälft*/Open and Closed Spaces—Enclosure and the Geography of the Exposed: Cottagers, Peasants and Estates in the Scanian Countryside during the First Half of the 19th Century (Institutionen för kulturgeografi och ekonomisk geografi, Lund University, 2005), English summary.

⁵⁶ Georges Hottenger, *La Propriété rurale en Lorraine: morcellement et remembrement* (Paris and Nancy, 1914), p. v.

open-field system of agriculture were brought to light. In 1798 a government official reported from the arable plain outside Dijon the case of a farmer in the village of Cessey who owned around 200 *journaux* (68.6 hectares) distributed in 432 separate plots. Most of these strips touched the land of other farmers on all four sides, meaning therefore that he had potentially 1,600 neighbours to deal with when carrying out day-to-day farming operations.⁵⁷

Informal acquisition and exchange of parcels offered a partial remedy it is true. John Broad⁵⁸ has retraced the estate management strategies pursued over two centuries by an English gentry family, the Verneys of Buckinghamshire. There are many similar examples of patient property accumulation and 'rounding' via deals struck between neighbours. The activities of Nicolas-Philippe Berbis, seigneur of Longecourt near Dijon, between 1753 and 1807 provide a particularly well-documented example.⁵⁹ But land swapping by powerful lords using the threat of litigation to spur the reluctant or the unwary scarcely offered the kind of solution envisaged by Enlightenment theorists. A reordered landscape presupposed the realignment of ditches and watercourses, the construction of new access roads and paths, and alterations to settlement patterns as well as the creation of compact farms.

In practice the systematic re-structuring of agricultural territory happened infrequently even in those localities where late eighteenth-century conditions suggested that it was most urgently needed. Whether envisaged by landlords, royal bureaucrats acting under the sway of the physiocrats, or even individual farmers such a reform generally engaged too many vested interests and presented too many opportunities for obstructionist behaviour on the part of freehold owners, particularly absentee owners and their tenants. We do know of a few cases that were pushed through by powerful seigniors; however the ultimate vision of the rational landscape architects was nowhere fully realized in the period of Agricultural Enlightenment—save possibly in Scandinavia. In the majority of European states root-and-branch land reform only began in earnest during the third and fourth quarters of the nineteenth century. In some countries, indeed, it began later still, with the result that variant forms of the open-field landscape persisted until the outbreak of the Second World War.⁶⁰

⁵⁷ A. N. F¹⁰292 *Mémoire* of Citizen Martin, *Commissaire du Directoire-Exécutif près l'Administration municipale du canton de Genlis*, 14 frimaire VII.

⁵⁸ John Broad, 'The Verneys as Enclosing Landlords, 1600–1800', in John Charters and David Hey (eds), *English Rural Society, 1500–1800. Essays in Honour of Joan Thirsk* (Cambridge, 1990), pp. 27–53.

⁵⁹ See Robert M. Schwartz, 'The Noble Profession of Seigneur in Eighteenth-Century Burgundy', in Jay M. Smith (ed.), *The French Nobility in the Eighteenth Century: Reassessments and New Approaches* (University Park, PA, 2006), pp. 91–107; also Louis Lignerot, 'Remembrements aux XVII^{ème} et XVIII^{ème} siècles', *Mémoires de la Société pour l'histoire du droit et des institutions des anciens pays bourguignons, comtois, et romands*, 33 (1975–76), 291–301; and Saint-Jacob, *Les Paysans de la Bourgogne du Nord*, p. 401.

⁶⁰ The Food and Agricultural Organisation of the United Nations commissioned in 1950 a preliminary survey of farm fragmentation in Europe, see *The Consolidation of Fragmented Holdings*.

Early modern cases of land consolidation have been reported from the Allgäu region of south-west Germany.⁶¹ We know, for instance that *Vereinödung*, that is to say enclosure which included the removal of farmsteads from the villages into the fields, occurred in the Ravensburg, Leutkirch, and Waldsee districts. In all probability this process started in the middle of the sixteenth century on newly reclaimed wetland and forest belonging to the Imperial Abbey of Kempten. It was greatly facilitated by the fact that such land would not normally have been subject to communal grazing, and also by the fact that Kempten emerged as a local nexus of land-surveying expertise. Yet only in 1791 was *Vereinödung* as a practice enshrined in a legislative text. Before that date it seems that the initiative often came from the peasant farmers themselves, although it is clear that by the end of the eighteenth century the practice was becoming recognized as a tool for systematic agricultural modernization. When Bavaria annexed the ecclesiastical mini-state of Kempten in 1803 a map was drawn up of the Iller River *Kreis* showing all the locations where this advanced form of enclosure had been implemented.⁶²

There is also some evidence of strip consolidation taking place under the aegis of the rulers of the principality of Brunswick-Wolfenbüttel in the second half of the eighteenth century, albeit without any very clear intention of transforming the open-field system of agriculture. Legislation to bring about consolidation was introduced to the Duchy of Nassau-Oranien in 1784, but again it stemmed from government survey work and the motivation seems to have been fiscal in the main. However, if we turn our attention to the experiments conducted by private individuals, evidence of 'enlightened' land reform becomes a little more plentiful. The Möglin estate appears to have been realigned at some point before it was acquired by Albrecht Daniel Thaer in 1804, and in Lower Saxony the career soldier Friedrich Ernst von Bülow carried out a consolidation of the scattered holdings of his manor at Essenrode in 1783, apparently with the agreement of villagers. A man with established credentials as an improving landowner, von Bülow collaborated closely with Thaer and in 1792 was appointed director of the Celle Agricultural Society. He also corresponded with the London Board of Agriculture. It appears that the village territory of Neuenheim in the Palatinate experienced consolidation at about this time as well, and so, in 1803, did Rempertshoven in Baden-Württemberg. In the latter case the farmers were obliged to move their dwellings out of the village.⁶³

In France we find a similar pattern: hesitancy on the part of government ministers who were daunted by the scale of the task and by the implication that statutory

⁶¹ See the comprehensive study by Peter Nowotny, *Vereinödung im Allgäu und in den angrenzenden Gebieten* (Kempten, 1984), especially part three.

⁶² Philip Wolfart, 'The Bishop's Peasants and the Lands below the Grünten: The Origins of Territoriality in the Late Eighteenth Century', (PhD dissertation, Queen's University, Ontario, 1997), p. 142, Figure 6; also Suzanne Cliff-Jüngling, 'Changes in the Population Geography of the Northern Lake Constance Region (Baden and Württemberg) 1870–1910' (Magisteriate of Arts dissertation, York University, Ontario, 1997), p. 82.

⁶³ For a survey map of the village territory before and after consolidation, see Michael Tracy, *Government and Agriculture in Western Europe*, 3rd edn. (Hemel Hempstead, 1989), pp. 10–11 Maps 2a and 2b.

authority would need to be invoked in order to compel participation. This latter consideration paralysed French government action on the question of *remembrement* until the Vichy-inspired law of 1941.⁶⁴ But we also find 'freelance' episodes of farmland consolidation at Rouvres-en-Plaine in Burgundy between 1703 and 1707, at Nonsard (Lorraine) in 1763, at Neuviller-sur-Moselle and Roville-devant-Bayon (Lorraine) in 1769–70, at Essarois (Burgundy) in 1788 and at Aiserey (Burgundy) at the very start of the nineteenth century. The twin operations carried out at Neuviller and Roville by Antoine Chaumont de La Galaizière, seignior of the Comté of Neuviller-sur-Moselle (subsequently renamed Chaumont-sur-Moselle) and intendant of Lorraine, provide the best evidence we have of Agricultural Enlightenment at work in this sphere. He agreed with ministers in Versailles that a consolidation of these two adjacent parishes where he was by far the largest land-owner should be carried out as a trial exercise for an edict of general enclosure applying to the whole of the kingdom. The edict never saw the light of day, perhaps because of the difficulties Chaumont de La Galaizière had encountered in securing compliance—even though in neither Neuviller nor Roville were farmers required to move their dwellings from the village. The government reimbursed Chaumont de La Galaizière for the cost of the operation notwithstanding.

These French examples of land reform at the microscopic level were all known to the Lorraine agronomist N.-L. François de Neufchâteau. When he entered government in the aftermath of the Revolution he attempted to restart the debate on *remembrement*, but with little success.⁶⁵ It is true that by this time the 'productivist' argument for farmland consolidation had become confused with the 'redistributionist' rhetoric of smallholder republicanism (see p. 145). Nowhere in the heartlands of Europe, in fact, did the reorganization of holdings make much headway in the first half of the nineteenth century. In Prussia legal obstacles preventing the rearrangement and enclosure of holdings were not removed until 1872; even then the process, known now as *Flurbereinigung*, marked time for several decades. Neither the Grand Duke of Baden, nor the King of Württemberg felt secure enough to extend agricultural reform in this direction either. Eventually a facilitating law was introduced to Baden in 1856. Similar measures were adopted in Bavaria after 1858, notably an instrumental law in 1887.

Agricultural land consolidation in Switzerland was influenced by these developments in southern Germany. Several cantons took the initiative even before the establishment of the Federal State (1848). In Schaffhausen, for instance, a provision for the regrouping of holdings was included in cadastral legislation of 1846. After 1848 the running was made by the canton of St. Gall which in 1866 profited from work underway to straighten the Rhine in order to address the issue of fragmentation. The canton of Aargau moved to adopt the Baden legislation on consolidation in 1875, but it was only in 1884 that the Federal government showed a willingness to intervene in this area. A law of 1893 offered financial assistance in

⁶⁴ Peter M. Jones, 'The Challenge of Land Reform in Eighteenth- and Nineteenth-Century France', *Past & Present*, 216 (August 2012), 34.

⁶⁵ See François de Neufchâteau, *Voyages agronomiques dans la sénatorerie de Dijon*; also Jones, 'The Challenge of Land Reform in France', 8, 13–14.

the form of grants to enable the cantons to promote agricultural improvement schemes relating to water control, drainage, and re-afforestation as well as farm consolidation. However, the evidence of implementation on the ground is decidedly modest. Between 1885 and 1900 only forty-six restructuring operations were actually brought to completion and they applied to a mere 1,577 hectares.⁶⁶

Since landholdings were not registered in England it is hard to judge precisely what factors were in play. An informal process of consolidation as an accompaniment to enclosure must surely have been under way in the central and southern open-field regions for here average farm size appears to have more than doubled in the century after 1700.⁶⁷ In Ireland the Land Acts of 1870, 1881, and 1885 addressed a number of agrarian problems, but were not specifically tasked with the issue of fragmentation. Only in 1891 were steps taken to identify the particularly 'congested districts' in the west of the country. This prepared the way for estates commissioners in 1903 to tackle the congestion in the countryside by purchasing whole estates from landlords with a view to improving them and rearranging holdings, before leasing them to new tenants.⁶⁸

Literary exponents of rational landscape planning such as the Scottish Jacobite Henry Pattullo⁶⁹ determined that one-fortieth of the available land surface would need to be set aside for hedges and ditches, but such a calculation presupposed that farmers would automatically enclose their reassigned fields and manage them differently from the past. In some cases this was a step too far. On the fertile agricultural plain to the south of Dijon, for instance, the majority of cultivators showed no desire to abandon collective rights over meadow and arable stubble whatever the theorists of Agricultural Enlightenment might have intended.⁷⁰ Similarly in Lorraine: the local agents of Chaumont de La Galaizière were taken aback to discover that despite the regrouping of strips and the partitioning of the common pasture of Roville, peasant smallholders showed little compunction about retaining the village herd and driving it onto 'private' stubble.⁷¹ In those countries (Denmark-Norway and Sweden) where the State actively and energetically sponsored land reform, therefore, policymakers learned to think through very carefully what they wished to achieve and to prescribe in advance every aspect of the consolidation operation that might be liable to misunderstanding or misinterpretation.

As we have noted already, consolidation and enclosure usually required major alterations to be made to rural infrastructure, whether to the built habitat or the so-called natural environment. In the 1790s and 1800s at the height of the land reform era in Denmark the government brought in French engineers to lay out straight toll roads. However, it is possible to trace the acceptance by some of the reformers of the need for a fundamental redrawing of landscapes and habitats to a

⁶⁶ *The Consolidation of Fragmented Holdings*, pp. 82–3, 99.

⁶⁷ Mokyr, *The Enlightened Economy*, p. 175.

⁶⁸ *The Consolidation of Fragmented Holdings*, pp. 65–6.

⁶⁹ Henry Pattullo, *Essai sur l'amélioration des terres* (Paris, 1758), p. 88; also François de Neufchâteau, *Voyages agronomiques dans la sénatorerie de Dijon*, pp. 43, 49, 85–7.

⁷⁰ Ligneron, 'Remembrements aux XVII^{ème} et XVIII^{ème} siècles', 297.

⁷¹ Jones, *Liberty and Locality*, pp. 243–4.

far earlier date. The first Nordic case of systematic enclosure entailing the dispersal of whole village communities seems to have taken place in southern Jutland around 1710–11.⁷² Although information about this episode is patchy, Palle Ove Christiansen's ethnological study of an estate in the eastern part of Denmark over a period two centuries does allow us to understand rather better what the process of land consolidation and landscape renewal actually implied on the ground.

The country estate of Giesegaard embraced the territory of twenty-four villages. Its heavily indebted owner began to modernize in the 1770s commencing with the manorial demesne or home farm, the combined holdings of which totalled around 163 hectares. This was the land which the head-steward, Søren Klestrup who had imbibed the philosophy of Agricultural Enlightenment, would slowly nudge in the direction of the Holstein system as we have seen. Reorganization of the production side of the farm between 1773 and 1800 resulted in a significant increase in the arable surfaces and, in good years, a doubling of the quantity of grain that could be taken to market. From the 1780s these efforts were seconded by the Danish State, albeit on a much broader front and it is interesting to see how events played out in one of the constituent villages of the manor.

The villagers of Gørslev had their farm strips scattered in between sixty and one hundred locations although they also possessed a large common pasture which was opened up for temporary tillage as and when the pressure of population required it. Drainage, the supply of manure, and the identity of the strips which resided exclusively in the collective memory were constant problems, it seems. Coordinating the cereal harvest was a further seasonal issue inasmuch as grain grown on south-facing strips ripened more quickly than that planted on the less sunny strips facing north. Palle Ove Christiansen remarks that 'the village was not a self-reposing ecosystem but a result of a deliberate intervening in nature's energy transformation with the aim of wresting from that nature a product'.⁷³ By the time of the State's reforms, it transpires, the tenanted farms were pressing against the limits of their growth potential. The arable surface had increased by one-third across the century, but chiefly at the expense of the pastures and the forest margins, which in turn had reduced the supply of manure and threatened to destabilize the village economy.

Land consolidation on the Giesegaard estate began in 1779—as a trial initiative by the steward Klestrup. However in Gørslev nothing much happened until 1797–98 when the University of Copenhagen, owner of two of the farms in the village, called for a general consolidation of all landholdings to be carried out. Unanimous support for the operation was not forthcoming. Cottagers wanted to know what compensation they would be receiving for the loss of their communal grazing rights, while farmers were exercised by the prospect of some of the dwellings being moved away from the village nucleus. Nevertheless, the consolidation went ahead: deep and dead-straight furrows were sliced across existing strips and drainage ditches and even across land enclosed earlier in order to mark out the new boundaries where earthen banks, dry-stone walls, or hedges were to be put in place.

⁷² Helmfrid, 'The *Storskifte*, *Enskifte* and *Laga Skifte* in Sweden', 122.

⁷³ Christiansen, *A Manorial World*, p. 152.

Political and economic decisions, Christiansen observes, were 'transformed into new spatial apportionments of resources'.⁷⁴ A star-shaped realignment of the agrarian landscape of Gørslev in which each farmstead held land radiating outwards from the nucleus would have avoided the need to relocate a number of the farms and would have reduced the costs of the operation, but the village was too large to allow such a solution with the result that the enclosure—in its spatial dimension—combined both 'star' and 'block' separation characteristics.

Altogether ten farmsteads were moved out into the new fields, leaving just eight in the village with less easy-to-work triangular land holdings, plus a number of cottages. Contrary to established peasant practice the estate officials insisted that the relocated farmsteads be erected at the highest and consequently the least sheltered points in the fields, while government policy stipulated that they must face south rather than north as previously. On the other hand, the manor supported the operation to the tune of 90–100 *rigsdalers* per farm removal and a smaller subsidy was provided by the Crown. Around 700 linear metres of farmhouse had to be dismantled, transported, and re-erected in the new locations, new access roads constructed, and miles of fencing laid out where previously there had been none of course. The question of who would move to the consolidated holdings outside the village and who would remain on those adjacent to the village was decided by the drawing of slips from a hat.

By 1800, it appears, the removal and rebuilding operation in Gørslev was complete, although it is less certain that customary grazing practices immediately responded to the new conditions of cultivation. The old village community broke up since it was no longer linked in an organic way to the agrarian landscape now emerging. The majority of the farms were independent and somewhat isolated production units with complete, or near complete control over their allocated territory, leaving the old village centre populated mainly by cottagers and craftworkers, some of whom had no access to land at all. Whether this transition unlocked hidden stores of productive energy as its architects had envisaged is the key question. After some delay, reflecting no doubt the labour involved in ploughing out the old strips and reconfiguring the landscape, there was a change in rotations and grain yields rose. However, it is hard to determine the precise nature of the productivity increase and to determine as well which element in this multifaceted process of radical enclosure was chiefly responsible for it.⁷⁵

The enclosure in 1786 of Vejen in southern Denmark studied by Fridlev Skrubbeltrang⁷⁶ proceeded more smoothly even though the site of the village was not central to the parish, meaning that nine farms and seven cottages had to relocate. Yet here there was no immediate pay-off in terms of agricultural modernization in what appears to have been a rather backward-looking locality. A version of the wheeled plough remained in widespread use in Vejen and only in the 1830s did the potato become a significant field crop. In Hejninge (West Zealand) we do not

⁷⁴ Christiansen, *A Manorial World*, p. 316.

⁷⁵ Christiansen, *A Manorial World*, pp. 325–7.

⁷⁶ Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark*, pp. 69, 96.

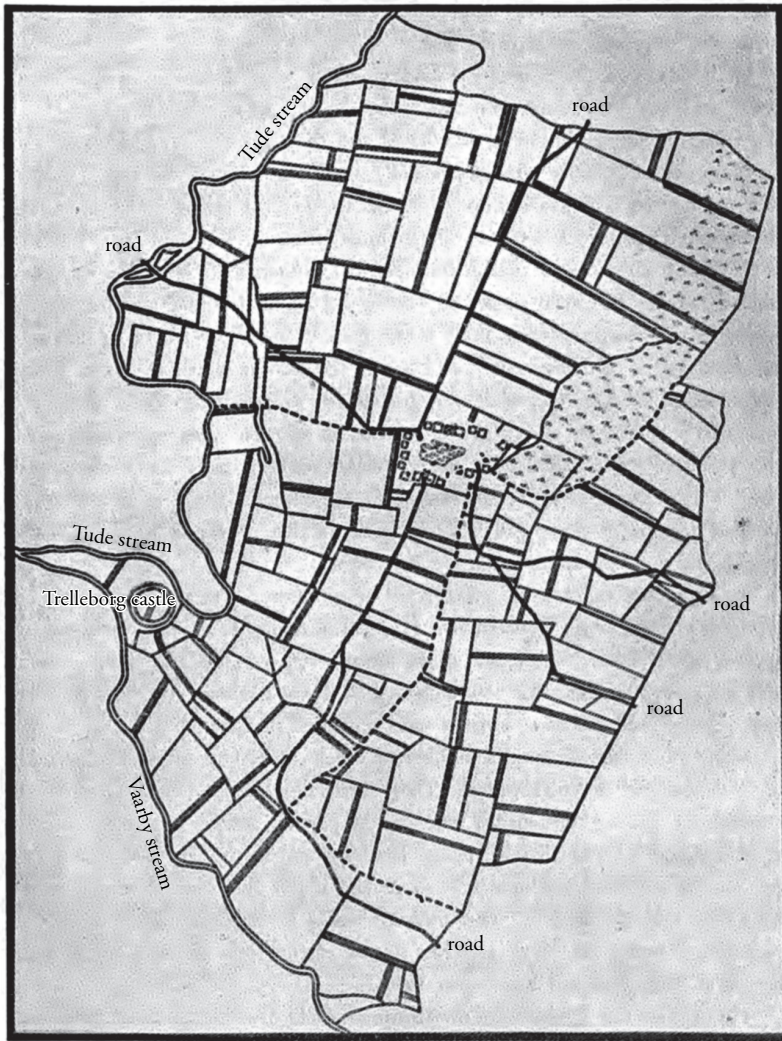


Figure 8.1. Village of Hejninge (West Zealand, Denmark) before consolidation, 1768

Source: F. Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark* (Rome, 1954). Map modified and redrawn.

know exactly how and when a productivity gain was achieved either, but this village is worth evoking and illustrating for the symmetry of its 1790 consolidation and enclosure. The refashioning of the old agrarian landscape of the village enabled all tenants' holdings to be brought together in one or two blocks of land. The dotted lines in Figure 8.1 indicate the original division of the village's territory into three open-fields while the shaded strips (115 in total) show the scatter of lands belonging to just one farmer prior to the re-allotment. After the re-allotment ten

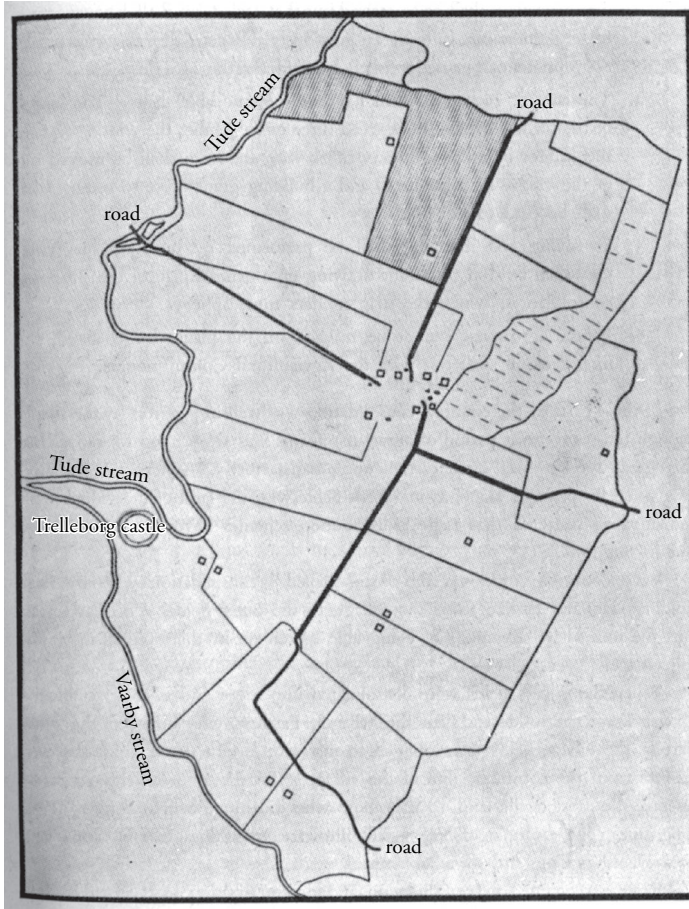


Figure 8.2. Village of Hejninge (West Zealand, Denmark) after consolidation, 1807

Source: F. Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark* (Rome, 1954). Map modified and redrawn.

of the seventeen farmhouses grouped originally around the village green were moved out into the fields (see Figure 8.2), although an attempt was made to position some of them opposite one another and close to the village roadways so as to mitigate the socially isolating impact of the reform.⁷⁷

The changes made to the topography, agrarian landscape, and human habitat of Denmark were palpable nearly everywhere by the 1810s. According to the econo-

⁷⁷ Skrubbeltrang, *Agricultural Development and Rural Reform in Denmark*, pp. 52–3; for the original study of Hejninge and the village maps, see Carl Rise Hansen and Axel Steenberg, *Jordfordeling og Udskeftning: Undersøgelser i tre Sjællandske Landsbyer/Land Distribution and Enclosure: Studies in Three Zealand Villages* (Copenhagen, 1951), plates VII and XI and for a summary in English, pp. 439–46, 466–7, 470, 472, 474–7. I am indebted to Dr Carsten Porskrog Rasmussen for helping me to find this book.

mist V. A. Falbe-Hansen writing in the centennial year of the abolition of adscription (1788), 'before enclosure one saw closely built villages with their vast fenceless fields and extensive untilled commons, where hordes of semi-starved cattle, horses, cows, sheep, pigs and geese trampled around seeking fodder on scanty grazings. After enclosure the land took on the appearance of the present day: many small fenced fields and the former commons transformed to cultivated fields with their farmsteads and cottages'.⁷⁸

The only other place in Europe to experience landscape and habitat restructuring on this scale was Sweden. Whereas the *storskifte* enclosures introduced in the 1750s did not set out directly to undermine the integrity of the village, the *enskifte* introduced by decree of 1803 and the *laga skifte* of 1827 most certainly did. They encouraged the creation of compact and geometric farms which had a dramatic morphological impact. The villages of the provinces of Scania and Bohuslän and parts of the plains of Västergötland were thinned out to leave just one or two farmers in each by the middle decades of the nineteenth century. Where the built environment permitted, a star mode of separation was adopted but no more than three farms could normally be accommodated within a territory redesigned along these lines for otherwise the consolidated holdings became too elongated and therefore expensive both to fence and to work.⁷⁹ As in Gørslev the more usual way to re-order the landscape was to combine both 'star' and 'block' which in the majority of cases presupposed a substantial exodus of farmers (between 50 and 60 per cent) from the villages. In the process Sweden's 'village-like character evaporated' to quote Carl-Johan Gadd,⁸⁰ with the result that by 1880 the countryside had taken on its present-day appearance of scattered farmsteads situated in the midst of compact holdings of arable land.

In this connection it is worth returning to the 'ferm touns' of Scotland (see p. 155). Whilst some of these hamlets of tenants would experience agricultural modernization in the form of conversion into single farmsteads, others would be expunged from the landscape altogether. From the 1750s they would be replaced with planned villages in a development which reversed the trend we have observed in Scandinavia. Scotland had no endogenous nucleated habitat, save perhaps in the Firth of Forth and towards the border with Northumberland, and these new village-like settlements came into being through the independent actions of landowners rather than those of governments or 'enlightened' reformers. Altogether around 490 planned settlements seem to have been established on the mainland of Scotland by the middle of the nineteenth century, and a similar development took place in Ireland as we have noted.⁸¹ All of the dwellings in the new villages were equipped with large gardens, an allotment of fields and a remit to open up and improve uncultivated land situated on the moors beyond the commonities.

⁷⁸ Cited in Friedmann, 'Fencing, Herding, and Tethering in Denmark', 596–7.

⁷⁹ See Helmfrid, 'The *Storskifte*, *Enskifte* and *Laga Skifte*', 127–9 and figures.

⁸⁰ Gadd, 'The Agricultural Revolution in Sweden, 1700–1870', in Myrdal and Morell (eds), *The Agrarian History of Sweden*, p. 153.

⁸¹ Douglas G. Lockhart, 'Lotted Lands and Planned Villages in North-East Scotland', *The Agricultural History Review*, 49:1 (2001), 17.

Incoming tenants might be required to drain the land and to excavate the peat mosses as well. Whilst all the indications suggest that landlords regarded these enterprises as lucrative investments which over time would boost their rental income, it is also possible to detect in their behaviour a preoccupation with the rational ordering of the landscape and a mission to improve for improvement's sake. Surveyors were called in to 'plan' the domestic units of each new settlement, the field lots were generally of a rectangular shape and lanes were inserted to ensure individual access.

Landscapes and habitats are not static and many of those described in this chapter changed again after the Second World War. Yet the ambition to adapt and hopefully to improve the natural environment articulated for the first time in the period of Agricultural Enlightenment remained a constant. We need to bear in mind, though, that modifications to the physical framework in which agriculture was carried on did not bring about, *ipso facto*, an alteration of cropping practices. Arthur Young's bafflement in the face of this paradox has already been mentioned and it was shared by many savant reformers.⁸² The continuing dependence of Europe's farmers on animal manure in any case set limits to the productivity of cereal agriculture, irrespective of how landscapes were reshaped or holdings distributed.

Change decreed from on high could work on the ground, but it was not bound to do so. In Denmark and Sweden governments persevered with the implementation of land reform even when the enthusiasms of other parties involved in the process began to ebb. Although it is hard to disentangle all of the factors in play, the economic return on institutional change in these instances is beyond dispute. However, other governments either lacked the bureaucratic muscle of the Nordic States, or failed to follow up their ambitions with really effective implementation *in situ*. Yet in the meantime ordinary farmers were scarcely slow in responding to opportunities for agricultural restructuring when they could see a clear economic advantage in doing so; for instance in Schleswig-Holstein or the territories of Kempton. In most of Europe, however, landscape and habitat reordering made little progress until the final quarter of the nineteenth century. By this time technological and scientific advances more or less ensured that direct intervention in the countryside to reshape agrarian structures would result in very significant yield increases.

⁸² 'The marvellous folly is, that, in nine-tenths of the inclosures of France, the system of management is precisely the same as in the open fields; that is to say, fallows as regularly prevail', *Travels during The Years 1787, 1788, and 1789* [...] *By Arthur Young* (Bury St-Edmunds, 1792), p. 393; also Jones, 'Arthur Young (1741–1820): For and Against', 1116.

Conclusion

Following a visit to Bradfield in the late summer of 1811 Marianne Francis, granddaughter of Dr Burney, recounted to Hester Piozzi the conviction of an elderly and now totally blind Arthur Young that the future of agriculture lay with the steam engine: 'Arthur Young believes in *steam engines*—& says it is the maxim of some famous farmer that the science will never be brought to perfection till every farm is a circle & the steam engine in the centre to do all the work'.¹ In fact the first cable-drawn plough using steam for traction was tried out in 1834—several years before a passenger vessel would rely on steam power to make the Atlantic crossing.² Viewing the rural economy through the lens of the Enlightenment as this book has done reinforces the proposition that for many educated and thoughtful individuals who reached maturity in the second half of the eighteenth century the possibility of material betterment was their overarching concern. Researchers now recognize that 'improvement' via the application of useful knowledge to productive processes provides one of the keys to a better understanding of the economic history of early modern Europe. Agricultural Enlightenment as we have labelled this phenomenon is in essence, therefore, an attempt to explore and weigh up the role played by ideas, innovative practices, and institutions understood in a broad sense in the agrarian sector of the economy.

The merits of this approach were first outlined by Joel Mokyr in a number of publications the most important of which for our purposes is a book bearing the evocative title *The Enlightened Economy*.³ Whilst acknowledging that the economic ramifications of the Enlightenment have not attracted much interest from scholars, Mokyr argues that the search for an explanation of growth in the early modern period should not be confined to the study of the staples of economic history

¹ Gazley, *The Life of Arthur Young*, p. 588.

² Bertrand Gille (ed.), *The History of Techniques*. 2 vols. (New York, London and Tokyo, 1986), ii, p. 644; also Rémi Carillon, 'Du baton à fouir à l'aube de la motorisation agricole' [1986], <http://documents.irevues.inist.fr> (accessed 23 February 2015). For a report on a trial, in 1837, of the ploughing engine of John Heathcoat and Josiah Parkes, see *The Farmer's Magazine*, July–December 1837, p. 479 'I was pleased to find that steam had again conquered difficulties, which neither the four-legged brutes, nor men could have done, even on hard land; that I could, by an almost invisible agency, impel to a distance of 320 yards, and bring back safely to me, a plough travelling on an undrained bog, poached and mashed as it was by 2,000 people, and by two days previous trampling.' Report by Josiah Parkes.

³ Joel Mokyr, *The Enlightened Economy: An Economic History of Britain, 1750–1850* (New Haven, CT, 2009).

(natural resource endowments, energy costs, living standards, capital accumulation, consumer demand, market integration, etc.). The rudiments of an explanation should also be sought in 'what people knew and believed, and how those beliefs affected their economic behavior'.⁴ The main focus of his enquiry is on Great Britain and its late eighteenth-century industrial 'take-off', but the emphasis placed on the accumulation and implementation of useful knowledge applies equally well to the putative Agricultural Revolution. In fact, he explicitly poses the all-important question, 'was there an Agricultural Enlightenment, comparable to the Industrial Enlightenment' which prepared the way for, or, at the very least, optimized the conditions for the great agrarian and industrial transformations that would take place across Europe during the second half of the nineteenth century?⁵ We have answered his question in the affirmative, albeit while sharing some doubts as to the existence of a close causal relationship between Agricultural Enlightenment and Agricultural Revolution, or indeed between Agricultural Revolution and Industrial Revolution.

Agricultural Enlightenment can be situated in time and place as we have seen. Its coordinates derive from the pan-European efflorescence of an economy of knowledge, a development which is detectable from the 1750s and which picked up momentum nearly everywhere in the 1760s and 1770s. The supply of useful knowledge would never be arrested, or even significantly curtailed thereafter. However, its form and content did alter, as did the manner in which it was diffused and implemented. By the 1840s scientific and technological knowledge spill-overs were starting to reshape European agriculture in a way that would make the fields, the field crops, and even the farmyards familiar to Arthur Young's generation a thing of the past. However, this transition from an Enlightenment-driven knowledge supply to a technology-driven transformation of husbandry and land use was neither predictable, nor even in terms of its impact. Nor did the change happen autonomously, that is to say in isolation from demand factors. Population pressures, skilled labour deficiencies, price fluctuations, short- and long-range market opportunities, and significant improvements to rural infrastructure all played their part. From the 1760s cereal prices rose across Europe and the prospect of a monetary gain from the land after decades of stagnation undoubtedly provided a stimulus to the production of useful knowledge.

Educated men and women of the Enlightenment generation envisaged information as an 'electrical fluid'⁶ that could be transmitted without effort from person to person. It was sufficient, therefore, to make knowledge in its more utilitarian forms available via the communication systems of the age and to sit back and await the results. In a period which tended to frown on specialization and treated savant discourse as a recreational activity designed mainly to bestow 'politeness' on participants, their interest in knowledge was omnivorous and, for the most part, superficial.

⁴ Mokyr, *The Enlightened Economy*, Introduction.

⁵ Mokyr, *The Enlightened Economy*, p. 171.

⁶ Jan Golinski, 'Joseph Priestley and the Chemical Sublime in British Public Science', in Bernadette Benssaude-Vincent and Christine Blondel (eds), *Science and Spectacle in the European Enlightenment* (Aldershot, 2008), p. 118.

These *Aufklärer* experienced difficulty grasping the truth that the electric fluid of agricultural theory would not be transmitted to working farmers in a similarly invisible yet instantaneous fashion. They spent their time in their cabinets constructing systems of agriculture which were rooted in the encyclopædic knowledge of the High Enlightenment decades. Even the 'rational' agriculturalists (Young, Sinclair, Thaer, etc.), whose rural knowledge was often 'farm-gate', that is to say empirical in origin tended to share the common misconception that the diffusion of ideas and practices relating to improved husbandry was tantamount to their implementation.

No doubt it is the recognition that knowledge was frequently packaged for the purposes of cultural exchange in the eighteenth century that has deterred economic historians from taking the Enlightenment to heart. As E. L. Jones has observed, the economic history of the Enlightenment is notably under-theorized—a sign perhaps of a pervasive assumption among specialists that a movement of ideas could scarcely have had independent leverage on the material forces responsible for bringing about change to infrastructures. Yet denial of the 'politico-intellectual background'⁷ runs the risk of taking us down the path of economic determinism and, in any case, two points are now reasonably well established that serve to bring the Enlightenment and the eighteenth-century economy back into historiographical alignment. At the level of practices if not at the level of philosophical discourse, it has been shown that the Enlightened posture manifested itself chiefly in a concern for attainable, incremental improvements in day-to-day conditions of living; and second that governments interpreted the phenomenon of Enlightenment as both an opportunity for and as a guide to the extraction of wealth from the land.

The new economic discourses which emerged out of the intellectual debates of the Enlightenment were examined in chapter one. As they matured in the fevered atmosphere of late-eighteenth century power politics, they would gradually be consolidated into bodies of 'State knowledge' with institutional and professional underpinnings. The construction of a discipline or rural science of agronomy is the best example of this process: it incorporated elements of both physiocracy and cameralism which lost their conceptual clarity as independent systems of economic thought after the turn of the century.

Political economy as we have described it was destined to enjoy a much longer existence, though. It sat astride the agriculture–industry divide which scarcely amounted to very much in the 1760s or the 1770s, but which was becoming more palpable and harder to bridge intellectually by the 1820s and 1830s. In this regard Great Britain, where agriculture would only contribute about a fifth of the gross domestic product of the country by the 1840s, pointed to the way ahead.⁸ Political economy, moreover, was being reinvigorated by an injection of free-market theory in the early decades of the nineteenth century. Yet, at the same time, it lost none of

⁷ Jones, *Locating the Industrial Revolution*, p. 244.

⁸ Niek Koning, *The Failure of Agrarian Capitalism: Agrarian Politics in the UK, Germany, the Netherlands and the USA, 1846–1919* (London and New York, 1994), pp. 50–1.

its power to analyse comparatively the 'wealth of nations'. The knowledge literature of these decades is full of complicated and questionable calculations intended to demonstrate how modern machinery was conferring on Britain a comparative advantage over, for example, France. Thus in 1827 the *Archives des découvertes et des inventions* published a report drawn originally from London's *The Globe* newspaper to the effect that Britain's all too visible stock of 15,000 steam engines carried out work equivalent to 375,000 horses, or 2 million male labourers. Since two acres were normally required to produce the food requirement for each draught animal over a year, it was therefore reckoned that steam-power technology freed up 750,000 acres of land that could be used for other profitable agricultural or industrial purposes.⁹

Calculations such as these simply elaborated upon observations made by the likes of Maximilien de Lazowski, Auget de Montyon,¹⁰ and Jacques Isoré back in the 1780s and 1790s. They were wrong-headed not because the method of macro-comparative analysis was intrinsically faulty, but because numerical data about population, energy sources, agriculture, and manufacturing industry were scanty and lacking in credibility. The science of *Statistik* had yet to shift from a qualitative to a quantitative footing in any case. Yet they were not wrong, or alone, in pointing to the background role played by institutions. 'Why was agriculture in England in a flourishing state?' asked Isoré, innovating agriculturist and one-time revolutionary in 1802: because of favourable laws, he responded, rather than particular systems of cultivation.¹¹

In chapter two we explored more closely the impact of institutions on agricultural growth, focusing specifically on the role of the State. Britain's governing elites showed themselves to be perfectly capable of absorbing the laissez-faire message of the Enlightenment; by and large they pursued a hands-off approach to agriculture from which they deviated only in moments of economic or political emergency. On the Continent, however, the institutional context was, generally speaking, much less favourable to wealth generation. Governments therefore chose, albeit with some trepidation, to intervene directly in the rural economy if only as a means of boosting tax receipts in the aftermath of ruinous wars. That said, though, it is far from clear that the great institutional 'events' of the age had the immediately beneficial effects that their progenitors had anticipated. The revolution in France in 1789 reached to the very grass roots, yet it left the fundamentals of open-field agriculture pretty much untouched. Indeed, some would argue that it actually deterred and delayed innovation in land use and cultivation techniques for a decade and more. Arthur Young came to this conclusion, and in 1791 the French chemist and improving landowner Antoine Lavoisier gave voice to the prevailing anxiety that Agricultural Enlightenment was about to stall when he complained of

⁹ *Archives des découvertes et des inventions nouvelles faites dans les sciences, les arts et les manufactures tant en France que dans les pays étrangers, pendant l'année 1827* [...] (Paris, 1828), 243–4.

¹⁰ Evelyne Zylberman, 'Auget de Montyon et l'agriculture' in Albert Rigaudière, Evelyne Zylberman, and René Mantel (eds), *Etudes d'histoire économique rurale au XVIII^e siècle* (Paris, 1965), pp. 117–28.

¹¹ Isoré, *Traité de la grande culture des terres*, p. 12.

a future informed by collective ignorance 'owing to the breach made in all the educations of the kingdom by the revolution'.¹²

The saga of peasant emancipation in the central European states raises similar doubts. In a country such as Prussia the legal process of emancipation was so protracted that it is hard to tell whether agricultural modernization in the first half of the nineteenth century owed more to the ending of personal servitude and the creation of private property rights or to population growth, steadily improving transport infrastructures and the consequential strengthening of markets. Whilst seigniorialism and the retention of land within the manor might impede agricultural innovation and growth, it was not bound to do so. Seigniors could behave like *rentiers*, but they could also behave like capitalists and in northern Europe the evidence suggests that more and more of them were learning to do so as cereal prices started to recover in the 1760s. Governments were learning too: learning how to use taxation not only for the routine and age-old purposes of surplus extraction, but for agricultural renewal as well. Universal land taxes as the eighteenth-century Bourbons, Habsburgs, and many more recent governments have discovered could be employed as a lever to induce peasants to work the land more intensively. The failure of the French revolutionaries to design a tax system that incorporated their agronomic agenda; indeed their failure to collect much tax revenue at all for nearly a decade goes some way towards explaining the lack of any incentive to modernize among those who worked the land. Instead the income windfall was squandered on further purchases of land and conspicuous consumption.

Reform of the rural economy delivered from on high posed a real problem of implementation in any case. In much, perhaps most, of continental Europe the agrarian question (how to modernize the rural economy) could not be tackled separately from the social question (how to overcome the clogging effects of juridically enshrined hierarchy and inequality). The strong bureaucratic states of Scandinavia were the only ones to resolve successfully this conundrum in the period of Agricultural Enlightenment. It should come as no surprise, then, that Denmark-Norway and Sweden constitute the two cases in our survey where the causal link between institutional reform and subsequent agricultural growth is best attested. In neither country can it be shown that the leisurely rates of urbanization and market integration before *c.*1850 provided much of a stimulus towards agrarian restructuring. Yet, by the mid 1820s, Sweden had moved from being an importer to a net exporter of grain and by the 1830s Denmark was starting to develop a highly efficient processed foods industry.

Sir John Sinclair was at pains to emphasize that information about agriculture was not subject to international 'jealousy': on the contrary it was open, portable, and above all 'polite'. Anyone, of any station in life, who cared to take an interest in the subject could participate in the process of generation and diffusion. This view was widely shared and it turned precepts about farming into one of the principal export commodities of the Enlightenment. The growth of a pan-European

¹² Chaldecott, 'Scientific Activities in Paris in 1791', 31.

taste for reading which Fichte¹³ drew attention to in 1805 necessarily engendered a concomitant habit of writing and, as the market for treatises on agriculture expanded, it boosted in turn a mini publishing industry specializing in the translation of agronomic texts. In chapter three we examined both the supply of printed knowledge and its packaging and delivery to the point of use. Much of this output was completely unusable of course; in fact it was never intended for practical use since it was pumped out in essay or belles lettres form by armchair theorists for *salon* consumption. Only towards the end of the century in places like Scotland did the literary conventions associated with 'politeness' start to give ground, allowing an indisputably utilitarian literature on farm and field to emerge and to reach its target.

The economic and patriotic societies charged with delivering the new agricultural wisdom to potential users were all too aware of this problem. Several urged their members to refrain from rhetoric and random flights of erudition and adopt a more colloquial, not to say down-to-earth style. However the message, when it did get through, was often reliant more on intermediaries who either lived in close proximity to ordinary farmers, or who were part-time farmers themselves. In this regard we have examined the credentials of improving landowners and gentry, substantial tenant farmers, land stewards, and agricultural experimenters emanating from the ranks of the rural clergy to name only the more obvious categories. The former were a phenomenon of Scotland by and large; or at least it was only in that country that their numbers and their control of the land was of a sufficient order to make a difference. The latter, by contrast, were thinly distributed among the Lutheran populations of Scandinavia, Germany, and eastern France. Beyond these observations no clear pattern as to the agents and instigators of Agricultural Enlightenment emerges, however. Even then, not all lairds were improvers and nor did all Lutheran clergymen go to the lengths of an Oberlin (see p. 76) in seeking to spread education and rustic enlightenment amongst their parishioners. Clergy who pioneered clover and planted potatoes taught by example, but anything more formal or more bookish was apt to produce diminishing returns. Pastor Mayer of Kupferzell near Crailsheim made the mistake of consigning his agronomic ideas to a *Kalender* or manual for local farmers, only to be accosted by furious peasants who rushed into the manse and flung copies of the offending publication on the floor.¹⁴

The repercussions of Agricultural Enlightenment at the practitioner level were weighed carefully in chapter four. In answer to those historians who question whether printed literature of any description penetrated the rural community, Joel Mokyr urges us to allow for the possibility that it was filtered through networks of personal contacts. This seems plausible even if rather hard to prove as a general proposition. Yet there is no shortage of examples which testify to the direct impact of agronomic writings on landlords and their tenants, nor of working

¹³ See Tim C. W. Blanning, *The Culture of Power and the Power of Culture: Old Regime Europe, 1660–1789* (Oxford, 2002), p. 140.

¹⁴ Thomas Robisheaux, *Rural Society and the Search for Order in Early Modern Germany* (Cambridge, 1989), pp. 257–8.

farmers recycling information which they had received having first tried it out in their fields. Unquestionably a great deal of agricultural knowledge remained tacit, that is to say not inscribed in books or systematized in compendia. It was transmitted orally, either at the farm gate or in the marketplace. Yet it seems unlikely that such knowledge circulated independently in a pure and untinctured state and much more probable that it formed a hybrid mass of practical wisdom, bookish information absorbed directly or indirectly, and acquired skills.

Diffusion can be considered the core activity of Agricultural Enlightenment as we have noted. However, a readily available and expanding supply of knowledge will tell us little about the conditions which determined whether it would be accepted and incorporated into farming practices, or held at bay. The same point holds with regard to agricultural technology however we define it, of course. Regional and local context, which might well be institutional, counted for everything in the eighteenth and early nineteenth centuries and we have come across many instances where mere knowledge of a previously unheard-of cropping practice or a reputedly superior technology did not result in rapid adoption. Invention and innovation pose a further problem since it is by no means certain that they can be linked closely either to knowledge supply or to market demand. Diffusion, innovation, and adoption, might appear to be elements of a continuum, but in the real agricultural world they seem often to have functioned as discrete phenomena. Social networks and the informal competition inspired by the reflex of 'emulation' must have played a part and—at landlord level—it may well be possible to explain instances of the innovation of field enclosure in this fashion. For example the radical land and cropping reforms pioneered by Count Hans Rantzau-Ascheberg in Holstein appear to have influenced A. G. von Moltke's activities on his estate at Bregentved in Zealand and he, in turn, inspired Baron Rutger Macklean to embark upon the reorganization of his Svaneholm property across the Sound in Scania.

Open-field innovation remains a puzzle, though. There can be no doubt that it happened, but on what scale, with what effects, and as a consequence of what process of decision-taking remains a mystery for the most part. That said it is reasonably clear that innovation in the vicinity of large towns was market-led whether it took the form of inserting fodder plants such as clover into an open-field rotation, or full-scale enclosure leading to convertible husbandry. Readily accessible supplies of urban manure and night soil must have persuaded some farmers that an adjustment to their habits and cropping practices in the light of the new ideas and technologies made sense and was worth broaching as a topic of conversation with their neighbours. However, this kind of intensification was highly localized and as several observers of Europe's evolving landscapes remarked at the time, it would not be safe to project more widely the innovative practices visible in the hinterland of cities such as London, Paris, Copenhagen, Hamburg, Berlin, or Barcelona.

By the time the mechanization of work in the fields and farmyards started to make a real impact on the lives of Europe's country dwellers the Enlightenment was well past its zenith. Yet if we adopt a broader and historically more appropriate definition of

technology which embraces skills as well as implements and machines there can be no doubt that there is a story to be told which belongs to the phase of Agricultural Enlightenment as well as to that of Agricultural Revolution. Johann Beckmann, the German cameralist who was the first to employ the term *Technologie*, proposed a natural history of craft knowledge and 'know-how' which fell squarely within the taxonomic preoccupations of the *siècle des lumières*. Agriculture, as we noted in chapter five, was central to his remit both as a productive system that could be theorized and as a specific category of craft expertise whose elements could be isolated and laid out for scrutiny. More recent research which invites consideration of technology as a socially constructed phenomenon has enabled us to take these insights further. In the case of agricultural technology several points are immediately apparent. In the first place it is clear that we are dealing with a body of knowledge and 'know-how' that circulated widely throughout Europe in the late eighteenth-century decades. It was, moreover, a hybrid technology in which men and women interacted to add skills to existing skills, while hand-tools and machines went through a near constant process of incremental adaptation and improvement, often metallurgical, which makes it rather difficult to say when and where a given implement or machine was first conceived and used in the fields.

The history of skilled labour mobility in its application to farming was retraced in chapter five and it demonstrates something else as well. Simply acquiring copies of the prototype ploughs, harrows, drills, and threshing devices that could be inspected in model rooms and machine cabinets in many of the capital cities of Europe actually achieved very little. Tools and machines without men and women who knew how to manipulate and operate them were of limited use. Hence the important role played by skilled farm and farmyard operatives, rural artisans, overseers, and stewards in the joint enterprise of agricultural improvement. Whether it was better to bring in qualified individuals from elsewhere, or to despatch malleable young men to distant locations (England, Scotland) where they could be trained in the use of the new technologies was a matter for debate. Skilled English male operatives were notorious on the Continent for their unbridled behaviour, although this verdict often translates into little more than a condemnation of their independent-minded outlook. Nevertheless, to judge from the case of Christopher Brown in Prussia (see p. 116), some landowners seem to have concluded that innovation delivered in the form of foreign expertise came at too high a price.

Gradually it dawned on the various bodies sponsoring Agricultural Enlightenment that technical expertise, whether it be the floating of meadows, the construction of field drains or the building of mechanical threshers, needed to be transferred as a 'package' in which the element of skill was only one among several ingredients crucial to the success of the enterprise. But uncritical worship of the machine died hard. In 1827 the *Bulletin des sciences agricoles et économiques* carried a rather condescending review of a recently published book which described scores of agricultural machines—adding the tart remark that 'the author appears to be possessed by mechanical demons'.¹⁵ Most of the machines were of American or English

¹⁵ *Bulletin des sciences agricoles et économiques*, 7 (1827), 65.

manufacture, it is true. Yet if machines and their extraordinary capacity to reduce agricultural labour costs exerted a mesmeric effect, would-be improvers continued to underrate and undervalue tacit knowledge—even those improvers with direct oversight of farming operations who were in a good position to take full measure of the skills employed in agricultural work. As we have had occasion to observe the management of the plough in a grain field or of the scythe in a hay meadow brought into play a great deal more than the intrinsic qualities of the implements or of the draught animals involved.

The introduction of labour-saving technologies allied to the widespread use on the land of ‘artificial’ fertilizers enabled the agricultural sector to achieve a net productivity increase after 1850; of this there can be little doubt. Before the mid-century point was reached, however, the situation was less clear-cut as we have noted in chapter six. That Agricultural Enlightenment would lead in the direction of Agricultural Revolution was by no means assured. Sustained and largely unanticipated population growth had thrust the European economy into a phase of transition and in parts of Europe farming struggled to keep up. Scottish landlords and their tenants responded successfully to demand stimuli as the Lowlands were rapidly turned into one of the most urbanized regions of Europe, and in Denmark food production rose twice as fast as the domestic population in the three decades after 1830.¹⁶ The population of England was largely supplied with home-grown wheat before 1850 as well.¹⁷ However, in Ireland and in parts of central Europe where neither urbanization nor industrialization were happening very swiftly the countryside became congested. In the absence of further efficiencies in land use, a bleak Malthusian future seemed to beckon. Yet agricultural intensification would eventually come to the rescue of continental Europe’s hungry populations of the 1840s. In the event the future turned out to be more Boserupian¹⁸ in shape than Malthusian, although it should not be forgotten that rural migration from Europe to the New World in the second half of the nineteenth century did much to alleviate the strain on food resources.

How this productivity breakthrough was actually achieved leaves plenty of room for research and debate. Whilst pausing to consider the role of leases and modes of tenure which are institutional factors properly speaking, we also examined in chapter six contemporary opinion regarding the optimal size of farms. On this issue the calculation of economic advantage was complicated by arguments advocating small farms as a means of stabilizing rural social structures or consolidating the legitimacy of unstable political regimes. The case of France is eloquent in this respect for all the post-1789 regimes viewed the preservation of the peasant farmer on his smallholding as a desirable object of policy for one reason or another. This

¹⁶ Bruce P. Lenman, *Enlightenment and Change: Scotland, 1746–1832*, 2nd edn. (Edinburgh, 2009), pp. 24–5; Christiansen, *A Manorial World*, p. 456.

¹⁷ Orwin and Whetham, *A History of British Agriculture*, p. 38.

¹⁸ The reference is to Ester Boserup, author of *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (London, 1993 [1st edn. 1965]) who argued that demographic growth spurs farmers to work their land more intensively given a favourable institutional context.

is not to question the capacity of some small farmers to generate high yields, albeit at the price of very high labour inputs. The cases of East Flanders (Belgium) or Zeeland (Netherlands) are well attested. However, it is implausible to suppose that the great mass of ordinary cultivators, many of whom would have been tenants-at-will or else sharecroppers, were agents of modernization. As peasant polyculturists their involvement in the market would have been restricted to garden, farmyard, and dairy products in the main: commercial grain-growing husbandry was generally confined to the bigger tenant farmers who were usually well capitalized and better able to take advantage of economies of scale.

Of course for many contemporary observers productivity was no mystery. They knew its secret. In his *View of the Agriculture of Oxfordshire* Arthur Young remarked that any discerning individual could tell an innovative farmer by his demeanour: 'if you go into Banbury-market next Thursday, you may distinguish the farmers from enclosures from those from open-fields; quite a different sort of men; the farmers are as much changed as their husbandry—quite new men, in point of knowledge and ideas'.¹⁹ What this suggests is that the readiness to seize on and profit from the opportunities enshrined in Agricultural Enlightenment was ultimately a trait of character. Thomas Davis, the Wiltshire land agent to whom we referred in chapter four, would have agreed for he considered that improvement turned chiefly on the aptitude and skill of the individual farmer rather than on the particular type of cultivation practised.²⁰

We can label such individuals variously—as 'pioneers', 'generators', 'adopters', 'implementers', and perhaps even as 'managers'.²¹ Palle Ove Christiansen in his close-focus ethnographic study of villagers attached to the estate of Giesegaard in Zealand calls them the 'strivers'. The peasant households of the manor, he found, tended to embrace one of two broad lifestyles: strivers were quick to commute the labour service which they owed to the manor when given the opportunity to do so in 1796, whereas 'fatalists' were not. The latter viewed the terms as being too onerous and were therefore content to carry on in the same mediocre condition as before. Both traits of character existed simultaneously and in all probability had long existed since they were mutually dependent. In Gørslev the strivers profited from the fatalists' grazing rights in return for a modest payment since the latter did not have enough stock to exploit the commons themselves. They also sowed strips in the village fields which the fatalists among the householders lacked either the horses or the seed-corn to cultivate themselves. On the other hand, the fatalists used their more go-getting neighbours as informal loan banks whenever they had

¹⁹ [A. Young], *View of the Agriculture of Oxfordshire. Drawn up for the Board of Agriculture and Internal Improvement* (London, 1809), p. 269.

²⁰ *General View of the Agriculture of Wiltshire: Drawn up and Published by Order of the Board of Agriculture and Internal Improvement. By Thomas Davis* (London, 1811), pp. 45–6; also Michael E. Turner, 'Sitting on the Fence of Parliamentary Enclosure: A Regressive Social Tax with Problematic Efficiency Gains', in Mark Overton, E. J. T. Collins, Michael E. Turner, and Donald N. McCloskey (eds), *Agricultural History: Papers Presented to the Economic History Society Conference, at Canterbury, Saturday 9 April 1983* (1983), p. 40.

²¹ See Adams, 'The Agents of Agricultural Change', in Parry and Slater (eds), *The Making of the Scottish Countryside*, pp. 159–60.

to meet unanticipated expenditures, and they sought the symbolic protection of the strivers by naming them as godparents to their children. The officials of the estate scorned the fatalists for their lack of ambition, but endeavoured to turn them into progressive farmers nonetheless.²²

The biggest steps towards the establishment of a solid epistemological foundation for agriculture were taken by chemists. In the middle decades of the nineteenth century a veritable science of agriculture took shape. This development was underscored by the elaboration of an experimental method which gave improves the confidence to claim that they were now in possession of a mass of theoretical and empirically validated knowledge with genuine predictive capacity. In chapter seven (and also in chapter one) we tracked the evolution of the 'encylopædic' spirit of the Enlightenment across the watershed of the French Revolution and the Napoleonic imperium in Europe as visions of total social transformation receded and were replaced with more pragmatic concerns. This transition produced some unanticipated results. Agronomists moved into the space occupied by chemists and became engrossed in soils and manures, both organic and inorganic. In the process the age-old link between knowledge, 'know-how', and experience within the agrarian economy was opened up for questioning and debate. Should ordinary farmers be entrusted with the responsibility of carrying out trials and securing the harvest of science, or should these tasks be carried out for them—by experts and specialist institutions? The procedures associated with the analysis of soils and manures and the nutrition of plants were now becoming so complex that voices were raised in support of the idea of corps of 'professional experimenters' (see p. 168). Eclectic agricultural improvement obtained on a hit-and-miss basis via the premium system no longer had much of a role to play.

Albrecht Daniel Thaer refused to be despondent about this reappraisal of the status of the farmer and the future direction of agriculture, unlike Mathieu de Dombasle. Rational agriculturalists, he concluded, should embrace the scientific approach and profit from it—much like oceanic sailors who used charts and instruments to navigate the unknown. Farmers who simply relied on experiential knowledge were destined to remain 'coastal travellers'²³ since their reluctance to move out of sight of land would swiftly override any inclination to innovate. But as we have observed, this scarcely satisfied the German chemist Justus Liebig who had little time for the day-to-day activities of farming. The university laboratory or rather the dedicated experiment station was, he maintained, the only fit and proper place in which to carry out trials and experiments into soil fertility and plant and animal physiology. While Liebig's chemistry was widely admired—by chemists—its relevance to agriculture remained a source of dispute. In the Netherlands the focus on civil and hydraulic engineering persisted whilst in Britain farmers showed greater faith in the labour-saving potential of agricultural machines than in chemical manures, or chemical treatments for plant blight. The apathy of English and

²² Christiansen, *A Manorial World*, pp. 217–18, 241, 249–50.

²³ Thaer, *Grundsätze der rationellen Landwirthschaft*, i, pp. 4–14 cited in Gray, 'From Household Economy to "Rational Agriculture"', in Jarausch and Jones (eds), *In Search of Liberal Germany*, p. 41.

Scottish politicians when it was suggested from time to time that the nation should be investing in the new branches of State knowledge scarcely encouraged them to think differently. Thus it was in France and above all in Germany that the professionalization and institutionalization of the science of agriculture made the greatest progress in the second half of the nineteenth century.

For as long as the land supply in Europe remained elastic, the option of applying the latest advances in scientific knowledge to the physical space within which farming took place offered another approach to the ultimate goal of a 'rational' agriculture. Europe's agrarian landscapes were the theme of chapter eight: it explored the Enlightenment notion of 'nature' tamed, reorganized, and put to work in the service of humankind. The fullest expression of this ambition was Johann Heinrich von Thünen's theorizing of an ideal agricultural territory ordered into concentric rings of crops ranked according to the costs involved in transporting them to a central marketplace. Historically speaking, land reclamation (from forest, heath, marsh, and bog) preceded land reorganization if only for the reason that it offered a relatively simple and technologically straightforward solution to the challenge of population growth. Of course, in the case of State-sponsored reclamation projects such as those undertaken by Frederick II of Prussia there was also a fiscal agenda involved. Such schemes provided an opportunity not only to tame the natural environment but also to redesign the human habitat to match the latest agronomic theories in the expectation that tax revenue would rise as a result.

Major changes to land use on the other hand raised the question of innovation which in turn brought into play, as we have seen, all the issues connected to the collective management of agriculture practised in open fields. The scattering of landholdings in the form of arable strips can be considered the defining characteristic of the landscapes of early modern Europe. Any attempt to alter the principle of dispersion, whether for economic or aesthetic reasons, was bound to result in significant alterations to the working environment. On the whole, though, root-and-branch land reform did not form part of the remit of Agricultural Enlightenment. Whilst the enclosure of existing fields or strips was talked about endlessly and sometimes acted upon, the consolidation of farming units so as to create a landscape consisting of compact blocks of arable and meadow was, with a few exceptions, only ever talked about. For the most part, therefore, its history belongs to the Agricultural Revolution—in other words to the second half of the nineteenth century. True, the bureaucratic monarchies of Scandinavia displayed a determination to restructure landholding many decades before other European States chose to grip this particular nettle. Their reforms presupposed the reshaping of the human habitat as well, and they were viewed as breathtakingly radical in an age where governments tended to think long and hard before intervening in the contractual relationships binding lord and peasant. In the eyes of the rest of Europe Parliamentary enclosure in England, *udskiftning* and *jordfordeling* in Denmark and the *storskifte*–*enskifte*–*laga skifte* edicts in Sweden smacked of coercion.

While François de Neufchâteau, the Enlightenment author, agronomist, and statesman who managed to survive the lethal party politics of the French

Revolution, would issue an early warning against the urge to do good by force (p. 45), it must be acknowledged that the pressures playing on Europe's agricultural systems were of a very different order in the second half of the nineteenth century. After the dearth and hardship of 1845–48 which turned out to be the last *ancien-régime*-style agrarian crisis anxiety over the food supply subsided in most countries. When the pressures were renewed in the final quarter of the century they came from an exogenous source. In the meantime, though, Europe's agriculture had started to break free from the organic, manure-intensive practices which had shaped its trajectory since the early Middle Ages. Those regions and districts which had long pioneered intensive land use in a bid to obtain high cereal yields were now being joined by many others as chemical fertilizers improved even the least promising of soils, creating in the process a range of new cropping possibilities and the wherewithal for a massive extension of the fat-stock and dairying industries. Furthermore, knowledge was reaching farmers on a scale that even the most optimistic of the eighteenth-century theorists of Agricultural Enlightenment would scarcely have considered possible. When John Klippart, secretary of the Ohio State Board of Agriculture, carried out a tour of inspection of the German experiment stations in 1865 he was struck above all by the rigorously methodical manner in which ordinary farmers now carried out their field operations: 'every one of the hundred thousand farmers in Saxony',²⁴ he claimed, was able to explain his choice of crop rotations and fertilizer use.

The body blow to agriculture in the final quarter of the nineteenth century came from overseas. In 1865 American grain and meat producers started to penetrate the European marketplace where they were able to undercut the prices charged by native suppliers. Commercial cereal farmers in northern Europe were particularly badly affected and together with landlords they petitioned the politicians for tariff protection—consciously or unconsciously emulating their forebears of 1815 who had been similarly exposed by the collapsing price of corn after the Napoleonic Wars. Over the next three and four decades government interventionism in the affairs of agriculture would become the norm in Europe. Even in Great Britain a Ministry of Agriculture was set up in 1889, although not without a good deal of carping about Statist intrusion in the rural sector. Only in countries such as Denmark where farmers switched from the production of grain to the production of dairy products in the third and fourth quarters of the century was the atmosphere of crisis in the rural economy somewhat attenuated. Grain constituted about 50 per cent of Danish exports in the 1850s but only 2 per cent by 1900, whereas the production of butter, bacon, and pig meat moved sharply in the opposite direction.²⁵

In these conditions agricultural policies which might have been considered coercive at the start of the century now appeared justifiable. In several States, in fact, the very notion of 'agricultural policy' was reformulated as prices of staples slid and the search began for alternative products and economies of scale. Such was the case in Imperial Germany where a comprehensive programme of legislative interventionism

²⁴ Finlay, 'Science, Practice and Politics', p. 353.

²⁵ Christiansen, *A Manorial World*, p. 459 Figure 11.1.

known as *Landeskulturgesetzgebung* took shape. This was the moment when structural reform of farmland not only appeared on the political agenda, but actually began to receive the force of law. The running was made in eastern Prussia, although about a fifth of the arable territory of Saxony seems to have been consolidated into larger fields by 1884.²⁶ Indeed, by this date a number of States were starting to introduce more or less compulsory measures designed to achieve the long-dreamt-of goal of truly efficient land use: Baden, Bavaria, Switzerland, and even France. In France government initiatives to encourage the grouping of open-field strips were hedged around by anxieties over consent and therefore rather timid, and they produced only modest results before 1914. In Germany, though, the impact on agricultural productivity of State-sponsored land consolidation was probably greater than that of the long-winded effort to wind up the feudal regime in the earlier part of the century.

Worries about soil exhaustion and the depletion of resources which the cultivation of forage legumes and then the rush into mineral and chemical fertilizers were partly designed to address were voiced at intervals and they have been highlighted by environmental historians. However, it is important to keep in proportion the ecological challenges facing Europe's agriculture as the century of the Industrial Revolution dawned. The supply of land, whether for food or industrial crops, was not about to run out. As we saw in chapter eight, there was still scope for 'extensification' and in any case 'intensification' was waiting in the wings. Moreover the ethic of agricultural improvement incorporated among other things the notion of sustainable development—even if the concept of 'resource management'²⁷ seems a little anachronistic when applied to early modern governments and farmers. To judge from the behaviour of the third Duke of Buccleuch as guided by his factor William Keir, Scottish improving landlords were very well aware of the need to set aside short-term advantage when planning for the future.

If Europe and more especially north-western Europe was not 'stretched to the limit'²⁸ and about to hit the ecological buffers by 1800, we are bound to question the scenario outlined by Kenneth Pomeranz²⁹ and a number of other scholars who have explored the question of differential development between East and West and formulated the 'Great Divergence' thesis. If the West succeeded in bringing together in a unique combination the ingredients for sustained agricultural and industrial growth, it began doing so long before the start of the nineteenth century.³⁰ The agrarian preconditions for growth in the more dynamic regions of Europe may

²⁶ Reiner Prass, *Reformprogramm und Bäuerliche Interessen: die Auflösung der traditionellen Gemeindeökonomie im südlichen Niedersachsen, 1750–1883* (Göttingen, 1997), p. 263.

²⁷ Warde, *Ecology, Economy and State Formation*, p. 163.

²⁸ Jones, *Locating the Industrial Revolution*, p. 76.

²⁹ Kenneth Pomeranz, *The Great Divergence: Europe, China and the Making of the Modern World Economy* (Princeton, NJ, 2000).

³⁰ Broadberry et al., *British Economic Growth*, pp. 384–6 and Stephen N. Broadberry, 'Accounting for the Great Divergence', 18 August 2014, <http://www.lse.ac.uk/economicHistory/pdf/> (accessed 21 July 2015). Note that K. Pomeranz no longer maintains that the more advanced parts of China remained in an economically comparable situation to that of north-west Europe as late as c.1800, see 'Ten Years After: Responses and Reconsiderations', *Historically Speaking*, 12:4 (2011), 20–5 cited in Broadberry et al., *British Economic Growth*, pp. 386–7.

well have been in place at the start of the fifteenth century; important (as it turned out) institutional pre-conditions can be identified in developments occurring in the sixteenth and seventeenth centuries, while the maturing of a useful knowledge economy allied to a culture of empiricism and a resolutely hands-on approach to science and technology—the phenomena which have been at the heart of this book—were overwhelmingly characteristics of the second half of the eighteenth and the early nineteenth centuries. It is true that these developments were hugely reinforced by the relatively late appearance on the scene of the activist State with a mandate to regulate—in the name of the public good—every branch of the rural economy.

While natural resource management in Europe generally may well compare rather unfavourably with that in the great agrarian-bureaucratic civilizations of the East, there can be no doubt that the north-west corner of the continent pioneered forms of land use which enabled the ceiling on agricultural production to be raised, and then preserved at a high level in less than favourable conditions after c.1400 whilst the rural economy of the rest of Europe descended into a long period of stagnation. This was also the region where other indicators favourable to growth in the longer term congregated, prompting Jan van Zanden³¹ and others to hypothesize a significant differentiation within Europe—or ‘Little Divergence’. Whether the very ‘long-run-way’ approach to growth adds much to our description and explanation of Europe’s Agricultural Enlightenment after 1750 may be questioned. Yet most, if not all, economic historians would agree that by the end of the sixteenth century the reserves of human capital (literacy, technological expertise, inventiveness, skill, etc.) slowly accumulating in the north-west corner of Europe had established a comparative advantage. This development owed much, in turn, to the size of urban populations, the sophistication of markets throughout the North Sea region, the growth of a high-wage craft sector, and the precocious appearance of institutions, be they credit institutions or laws enshrining individual property rights, which served both to protect and to incentivize those who either owned land, or who were directly engaged in the extraction of wealth from it.

The eighteenth century in Europe can therefore be described as the era which brought together for the first time the ingredients that would define the modern world. It is our contention that the Enlightenment played a key role in this process. Knowledge and particularly useful knowledge had never before been made so widely or so freely available. Attitudes were forged in this century which released in men and women the urge to investigate nature and the confidence to try and improve upon it. This knowledge, in tandem with a cast of mind which valued experiment and entrepreneurship, laid the foundations for the innovative technological growth of the nineteenth century. Agriculture would benefit from this extraordinary growth trajectory no less than the extractive and the manufacturing industries.

³¹ Luiten van Zanden, *The Long Road to the Industrial Revolution*, part two.

Bibliography

MANUSCRIPTS

Archives Nationales, Paris

27AP1 Fonds François de Neufchâteau

dossier 5: correspondance avec Sir John Sinclair.

27AP2 Fonds François de Neufchâteau

dossier 2: rapport sur la nécessité du remembrement des terres, correspondance à ce sujet.

dossier 3: aperçu des principes d'agriculture de M. le Conseiller d'Etat Thaer.

27AP4 Fonds François de Neufchâteau

dossier 4: Extrait du *Moniteur universel* du 27 brumaire an XIV/18 novembre 1805.

27AP17 Fonds François de Neufchâteau

dossier 1: Mélanges; Voyage agronomique dans la Sénatorerie de Dijon.

F¹⁰223 Commission d'agriculture et des arts

Garat, ministre de l'intérieur par intérim à Messieurs Bourdieu, Chollet & Bourdieu à Londres [n. d.].

F¹⁰ 260 Société royale d'agriculture de Paris

Exposé des travaux de la Société royale d'agriculture par M. Broussonet, 1786.

F¹⁰292 Propriétés rurales, mémoires d'économie agricole, an II–1815

Mémoire of Citizen Martin, Commissaire du Directoire-Exécutif près l'Administration municipale du canton de Genlis, 14 frimaire an VII.

Archives Départementales de l'Oise, Beauvais

6Jp 13 Chartier de Liancourt: correspondances diverses.

6Jp 14 Chartier de Liancourt: agriculture, manufactures.

Etat de l'agriculture en Angleterre. Comparaison de son agriculture avec celle du royaume de France; causes de son avancement, moyen d'amener une révolution dans la culture en France' 86 folios [n. d.].

1Q2⁴ Petition of Richard Reeve to the administrators of the District of Clermont, 21 August 1793.

1Q3531 Louveaucourt 'dite la ferme anglaise'.

British Library, London

Add MSS 34821–34854 'The Elements and Practice of Agriculture' by Arthur Young (1818).

Add MSS 35126 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35127 Correspondence addressed to Arthur Young (1741–1820).

Add MSS W35128 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35129 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35130 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35131 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35132 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 35133 Correspondence addressed to Arthur Young (1741–1820).

Add MSS 42095 Account of a tour in England written in the form of a series of letters by François de La Rochefoucauld, 1785.

THESES AND UNPUBLISHED PAPERS

Abou El Maaty, Khalil Nagwa, 'La Scolarisation de l'apprentissage agricole en France: les fermes-écoles au service de l'agriculture et de son enseignement (19^e siècle-début 20^e siècle)', 3 vols. (Thèse de doctorat, Université de Paris IV Sorbonne, 2007).

Bonnyman, Brian D., 'Agricultural Improvement in the Scottish Enlightenment: The Third Duke of Buccleuch, William Keir and the Buccleuch Estates, 1751–1812' (PhD dissertation, University of Edinburgh, 2005).

Bruton, Roger N., 'The Shropshire Enlightenment: A Regional Study of Intellectual Activity in the Late Eighteenth and Early Nineteenth Centuries' (PhD dissertation, University of Birmingham, 2015).

Cliff-Jüngling, Susanne, 'Changes in the Population Geography of the Northern Lake Constance Region (Baden and Württemberg) 1870–1910' (Magisteriate of Arts dissertation, York University, Ontario, 1997).

Finlay, Mark R., 'Science, Practice and Politics: German Agricultural Experiment Stations in the Nineteenth Century' (PhD dissertation, Iowa State University, 1992).

Gold, Carol, 'The Danish Reform Era, 1784–1800' (PhD dissertation, University of Wisconsin-Madison, 1975).

Herment, Laurent, 'Julien Gabriel Sugy's Agrarian Knowledge', paper prepared for Rural History 2013 [EURHO], University of Berne, 19–21 August 2013.

Jahier, Hugues, 'Angleterre et Suisse Romande: étude sur le commerce européen au XVIII^e siècle', 2 vols. (Thèse de doctorat d'état, Université de Paris IV Sorbonne, 1994).

James, Frank A. J. L. "Agricultural Chymistry is at present in it's infancy": The Board of Agriculture, The Royal Institution and Humphry Davy', unpublished paper.

Kent, Max L., 'The British Enlightenment and the Spirit of the Industrial Revolution: The Society for the Encouragement of Arts, Manufactures and Commerce (1754–1815)' (PhD dissertation, University of California, Los Angeles, 2007).

Knittel, Fabien, 'Mathieu de Dombasle: Agronomie et innovation 1750–1850' (Thèse de doctorat, Université de Nancy II, 2007).

Lowood, Henry E. 'Patriotism, Profit and the Promotion of Science in the German Enlightenment: The Economic and Scientific Societies, 1760–1815' (PhD dissertation, University of California, Berkeley, 1987).

Myrdal, Janken, 'Agrarian Literature in Scandinavia and in Britain, Ireland and North America during the 18th Century', paper prepared for Rural History 2013 [EURHO], University of Berne, 19–21 August 2013.

Pfister, Ulrich, 'Institutional Change and Agricultural Growth in Late Eighteenth- and Nineteenth-Century Germany: A Survey', paper presented to the workshop 'Government and Agricultural Change in Comparative Perspective', Lund University, Sweden, 16–17 October 2014.

Svensson, Patrick, 'Why Did Enclosures Matter in Scandinavia, when They Didn't in Britain?' paper presented to the Social Science History Association Meeting, Miami, 22–26 October 2008.

- Wolfart, Philip, 'The Bishop's Peasants and the Lands below the Grünten: The Origins of Territoriality in the Late Eighteenth Century' (PhD dissertation, Queen's University, Ontario, 1997).
- Yarrington, Jonna M., 'Droits and Frontières: Sugar and the Edge of France, 1800–1860' (MA dissertation, University of Arizona, 2014).

PRINTED SOURCES

Primary Sources

- Achard, F. K., *Die europäische Zuckerfabrication aus Runkelrüben*. 3 vols. (Leipzig, 1809).
- Annales agricoles de Roville, ou mélanges d'agriculture, d'économie rurale et de législation agricole; par C.-J.-A. Mathieu de Dombasle* 9 vols (Paris, 1824–1837).
- Annales de chimie et de physique* Vol. 37 (Paris, 1828).
- Annales scientifiques et administratives de l'agriculture française* Vol. 1 (Paris, 1829).
- Annals of Agriculture, and other useful Arts collected and published by Arthur Young Esq. FRS* 37 vols. (London and Bury St-Edmunds, 1784–1801).
- Archives des découvertes et des inventions nouvelles faites dans les sciences, les arts et les manufactures tant en France que dans les pays étrangers, pendant l'année 1827 [...] (Paris, 1828).*
- Arndt, Ernst, Moritz, *Reise durch Schweden im Jahr 1804*. 4 vols. (Berlin, 1806).
- Arrêté de l'administration centrale des Vosges, sur un moyen préliminaire d'encourager l'agriculture dans ce département, par la réunion des propriétés morcelées, et par quelques autres mesures: séance du 15 floréal, an V de la République française une et indivisible*. (Epinal, 1797).
- Avis aux ouvriers en fer sur la fabrication de l'acier. Publié par ordre du Comité de Salut Public* (Paris, [1793]).
- Baden, Torkel, *Beskrivelse over den paa Godset Bernstorff i Gientofte Sogn under Kiøbenhavn's Amt* (Copenhagen, 1774).
- Bailey, William, *The Advancement of Arts, Manufactures, and Commerce or Descriptions of the Useful Machines and Models contained in the Repository of the Society for the Encouragement of Arts, Manufactures, and Commerce [...] 2 vols.* (London, 1772).
- Balsamo, Paolo, 'Some Particulars relating to Flanders Husbandry by Signor Paolo Balsamo'. *Annals of Agriculture* vol. 14 (1790): 325–58.
- Beckmann, Johann, *Grundsätze der deutschen Landwirtschaft* (Göttingen, 1769).
- Beckmann, Johann, *Anleitung zur Technologie [...] (Göttingen, 1777).*
- Beckmann, Johann, *Entwurf der allgemeinen Technologie* (Göttingen, 1806).
- [Bécus, Edouard], *Mathieu de Dombasle sa vie et ses œuvres par Edouard Bécus, agriculteur* (Paris and Nancy, 1874).
- Begtrup, Gregers, *Beskrivelse af Agerdyrkningens Tilstand i Danmark*. 7 vols. (Copenhagen, 1803–1810).
- Berchtold, Leopold Graf von, *An Essay to Direct and Extend the Enquiries of Patriotic Travellers*. 2 vols. (London, 1789).
- Bibliothèque britannique*, 20 vols. (1796–1815).
- [Block, Maurice], *Des charges de l'agriculture dans les divers pays de l'Europe par Maurice Block* (Paris, 1851).
- [Boetticher, Jakob Gottlieb Isaak], *Statistical Tables; exhibiting a View of all the States of Europe showing with the greatest accuracy, their population, military and marine strength, revenue and expenditure, form of government [...] Translated from the German of J. G. Boetticher, of Koenigsberg* (London, 1800).

- Boyd Julian P. (ed.), *The Papers of Thomas Jefferson*. 24 vols. (Princeton, NJ, 1950–90).
- Bulletin de la Société d'encouragement pour l'industrie nationale*. 10 vols. (1802–11).
- Bulletin des sciences agricoles et économiques*. 8 vols. (1824–27).
- Bulletin des sciences agricoles et économiques*. Vol. 17 (1831).
- Burke, John French, *British Husbandry; Exhibiting the Farming Practice in Various parts of the United Kingdom*. 2 vols. (London, 1834).
- [Caird, James], *English Agriculture 1850–51*. By James Caird Esq. 2nd ed. (London, 1852).
- Carlyle, Thomas, 'Signs of the Times'. *The Edinburgh Review* Vol. 49 (June 1829): 439–59.
- Chaptal, Jean-Antoine Comte, *Chimie appliquée à l'agriculture*. 2 vols. (Paris, 1823).
- Chłapowski, Dezydery A., *O Rólnictwie*. 4th edn. (Poznań, 1875).
- Communications to the Board of Agriculture; on farm buildings etc. With preliminary observations on the origin of the Board of Agriculture* (London, 1796).
- Communications to the Board of Agriculture; on Subjects relative to the Husbandry and Internal Improvement of the Country*. 7 Vols. (London, 1797–1811).
- Courtin, Eustache-Marie-Pierre, *Encyclopédie moderne ou dictionnaire abrégé des hommes et des sciences, des lettres et des arts*. 24 vols. (1827–32), xxi.
- Crud, Baron Elie-Victor-Benjamin, *Economie théorique et pratique de l'agriculture*. 2 vols. (Paris, 1839).
- [Davis, Thomas], *General View of the Agriculture of Wiltshire: Drawn up and Published by Order of the Board of Agriculture and Internal Improvement*. By Thomas Davis (London, 1811).
- [Davy, Sir Humphry], *Elements of Agricultural Chemistry in a Course of Lectures for the Board of Agriculture*. By Sir Humphry Davy (London, 1813).
- Donnant, Denis-François, *Eléments de statistique où l'on démontre, d'après un principe entièrement neuf les ressources de chaque Royaume, Etat et République* (Paris, 1801–02).
- Doskey, John S. (ed.), *The European Journals of William Maclure* (Philadelphia, 1988).
- Du Pont, Pierre-Samuel, 'On the Commercial Errors of England'. *Annals of Agriculture* Vol. 16 (1791): 155–72.
- Duhamel du Monceau, *Traité de la culture des terres*. 6 vols. (Paris, 1750–61).
- Duhamel du Monceau, Henri-Louis, *The Elements of Agriculture by M. Duhamel du Monceau [...] by Philip Miller FRS*. 2 vols. (London, 1764).
- Dundonald, Earl of [Archibald Cochrane], *A Treatise Shewing the Intimate Connection that Subsists between Agriculture and Chemistry [...] (London, 1795)*.
- Elsner, Johann G., *Landwirtschaftliche Reise durch Schliesen* (Breslau, 1823).
- [Fawtier, Joseph-Clarys], *Mathieu de Dombasle. Lettre à MM. Les membres de la Société centrale d'agriculture de Nancy par J.-C. Fawtier, fermier, élève de Roville membre correspondant* (Nancy and Paris, 1845).
- [Fellenberg, Emanuel], *Vues relatives à l'agriculture de la Suisse et aux moyens de la perfectionner*. Par Emanuel Fellenberg [sic]. Traduit de l'Allemand par Charles Pictet (Geneva, 1808).
- Fordyce, George, *Elements of Agriculture and Vegetation* (London, 1771).
- [François de Neufchâteau, Nicolas-Louis-François], *Voyages agronomiques dans la sénatorerie de Dijon contenant l'exposition du moyen employé avec succès, depuis un siècle, pour corriger l'abus de la désunion des Terres, par la manière de tracer les chemins d'exploitation [...] Par N. François (De Neufchâteau)* (Paris, 1806).
- Gazette nationale ou le Moniteur universel, lundi 27 brumaire an 14 de la République* (Paris, 1805).
- Guillory, Pierre-Constant, *Notice sur le marquis de Turbilly, agronome angevin du XVIII^e siècle* (Angers, 1849).

- [Gyllenborg, Gustavus Adolphus], *The Natural and Chemical Elements of Agriculture. Translated from the Latin of Count Gustavus Adolphus Gyllenborg; by John Mills F. R. S.* (London, 1770).
- Hales, Stephen BD FRS, *Vegetable Staticks: or, an Account of some statical Experiments on the sap in Vegetables: being an Essay towards a Natural History of Vegetation [...]* (London, 1727).
- Headrick, Rev. James, 'Effects of Manures in the Production of Plants'. *Annals of Agriculture* Vol. 33 (1799): 275–301.
- Home, Francis, *The Principles of Agriculture and Vegetation*. 3rd edn. (London, 1776).
- Home, Henry [Lord Kames], *The Gentleman Farmer: Being an Attempt to Improve Agriculture by Subjecting it to the Test of Rational Principles* (Edinburgh and London, 1776).
- Isoré, Jacques, *Traité de la grande culture des terres: Ouvrage utile à tous les cultivateurs et aux personnes qui voudraient faire valoir de grandes exploitations*. 2 vols in 1. (Paris an XI/1802).
- Jacob, William, *A View of Agriculture, Manufactures, Statistics, and State of Society of Germany and Parts of Holland and France taken during a Journey through those Countries in 1819* (London, 1819).
- Johnston, James F. W., *Experimental Agriculture Being the Results of Past, and Suggestions for Future Experiments in Scientific and Practical Agriculture* (Edinburgh and London, 1849).
- L'Année littéraire* (Amsterdam, 1761).
- Lavoisier, Antoine, *De la richesse territoriale du royaume de France: Texte et documents présentés par Jean-Claude Perrot* (Paris, 1988).
- [Léonce de Lavergne, Louis-Gabriel], *The Rural Economy of England, Scotland, and Ireland by Léonce de Lavergne; translated from the French with Notes by a Scottish Farmer* (Edinburgh, 1855).
- Lullin de Chateaueux, Frédéric, *Voyages agronomiques en France* (Paris, 1845).
- Malthus, Thomas R., *An Essay on the Principle of Population as it affects the future improvement of Society [...]* (London, 1798).
- Marcet, Jane, *Conversations on Political Economy; in which the Elements of that Science are familiarly explained* (London, 1816).
- [Marshall, Joseph], *Travels through France and Spain, in the Years 1770 and 1771. In which is particularly minuted, the present state of those countries, respecting the agriculture, population, manufactures, commerce, the arts, and useful undertakings. By Joseph Marshall Esq.* (London, 1776).
- Marshall, William, *On the Landed Property of England, an Elementary and Practical Treatise* (London, 1804).
- [Mathieu de Dombasle, Christophe-Joseph-Alexandre] *Examen critique des élémens de chimie agricole de M. Davy par C.-J.-A. Mathieu de Dombasle* (Paris, 1820).
- Mathieu de Dombasle, Christophe-Joseph-Alexandre, *Faits et observations sur la fabrication du sucre des betteraves*. 2nd edn. (Paris, 1821).
- Mathieu de Dombasle, Christophe-Joseph-Alexandre, *Mémoire sur la charrue considérée principalement sous le rapport de la présence ou l'absence de l'avant train par C.-J.-A. Mathieu de Dombasle [...]* suivi de deux rapports faits à la Société, par M. Héricart de Thury (Paris, 1821).
- Mémoires d'agriculture, d'économie rurale et domestique, publiés par la Société d'Agriculture du département de la Seine*. Imprimés par Arrêté du préfet du Département Vol. 4 (Paris, an XI/1803).
- Mémoires de la Société d'agriculture de la Seine* Vol. 8 (an XIV/1805).
- Memoirs, Correspondence and Private Papers of Thomas Jefferson, Late President of the United States edited by Thomas Jefferson Randolph*. 4 vols. (London, 1829).

- Memoirs of the Life and Works of the Late Right Honourable Sir John Sinclair, bart.* 2 vols. (London, 1837).
- Morellet, André abbé, *Prospectus d'un nouveau dictionnaire de commerce [...] en cinq volumes in-folio proposés par Souscription* (Paris, 1769).
- Norton, Jane E. (ed.), *The Letters of Edward Gibbon*. 3 vols. (London, 1956).
- Oest, Nicolaus, *Oeconomisch-practische Anweisung zur Einfriedigung der Länderein nebst einem Anhang von der Art und Weise, wie die Feldsteine können gesprengt und gespalten werden, auch nöthigen Kupfern* (Flensburg, 1767).
- Pattullo, Henry, *Essai sur l'amélioration des terres* (Paris, 1758).
- Perret, Jean-Jacques, *Mémoire sur l'acier: dans lequel on traite des différentes qualités de ce métal, de la forge, du bon emploi & de la trempe, ouvrage couronné par la Société des arts de Genève le 19 décembre 1777*.
- [Pictet, Marc-Auguste], *Marc-Auguste Pictet, 1752–1825. Correspondance: sciences et techniques*. 3 vols. (Geneva, 1996–2000).
- [Pictet, Marc-Auguste], *Marc-Auguste Pictet, 1752–1825. Correspondance: sciences et techniques*, vol. 4: *Les correspondances suisses, italiens, allemands et autres. Etabli par René Sigrist* (Geneva, 2004).
- Pigeonneau, Henri and Foville, Alfred de, *L'Administration de l'agriculture au Contrôle Général des Finances (1785–1787). Procès-verbaux et rapports* (Paris, 1882).
- [Playfair, Lyon], *Memoirs and Correspondence of Lyon Playfair, First Lord Playfair of St Andrews by Wemyss Reid* (New York and London, 1899).
- Playfair, William, *The Commercial and Political Atlas, representing, by means of stained Copper-Plate Charts, the Exports, Imports and general Trade of England; at a single View* (various editions, 1786–1801).
- Précis du discours du Chevalier Jean Sinclair, baronet, président, aux Seigneurs Commissaires du Bureau britannique d'Agriculture, assemblés pour la première fois à l'ouverture du bureau, le 4 septembre 1793* (London, 1793).
- Quelques notes sur M. De Dombasle et sur l'influence qu'il a exercée par un élève de Roville* (Nancy, 1846).
- Rapport de M^r D. A. Chavannes à ses commettans sur l'institut d'éducation des pauvres à Hofwyl [...] Tiré des 51 et 52^e volumes de la Bibliothèque britannique. Division littérature* (Paris and Geneva, 1813).
- Recueil des lettres circulaires, instructions, programmes, discours et autres actes publics émanés du C^{en} FRANÇOIS (de Neufchâteau)* (Paris, an VII).
- [Reverdil, Elie-Salomon-François] *Struensee et la cour de Copenhague, 1760–1772 mémoires de Reverdil [...] précédés d'une courte notice sur l'auteur et suivis de lettres inédites* (Paris, 1858).
- Ricardo, David, *Principles of Political Economy, and Taxation*. 3rd edn. (London, 1821).
- Robinson, Eric and McKie, Douglas (eds), *Partners in Science: Letters of James Watt and Joseph Black* (Cambridge, MA, 1969).
- Ronna, Antoine, *Rothamsted. Trente années d'expériences agricoles de MM. Lawes et Gilbert* (Paris, 1877).
- Rougier-Labergerie, Jean-Baptiste, *Traité d'agriculture pratique ou annuaire des cultivateurs du département de la Creuse et pays circonvoisins [...] (Paris an III/1795)*.
- Rougier de la Bergerie, Jean-Baptiste Baron, *Considérations générales sur l'histoire, servant d'introduire à l'histoire de l'agriculture ancienne et moderne en Europe* (Paris, 1829).
- [Royer, Charles-Edouard], *L'Agriculture allemande, ses écoles, son organisation, ses mœurs et ses pratiques les plus récents par Royer inspecteur de l'agriculture* (Paris, 1847).

- 'Russian Travelling Sketches, no. 11'. *The New Monthly Magazine, and Literary Journal* Vol. 10 (1825): 209–13.
- Saussure, Nicolas-Théodore, *Recherches chimiques sur la végétation* (Paris, 1804).
- Sinclair, John, *The Code of Agriculture including Observations on Gardens, Orchards, Woods and Plantations with an Account of all the Recent Improvements in the Management of Arable and Grass Lands* (London, 1821).
- Small, James, *A Treatise on Ploughs and Wheel Carriages* (Edinburgh, 1784).
- Smith, Adam, *An Enquiry into the Nature and Causes of the Wealth of Nations* (London, 1776).
- [Smith, Sir James Edward], *Memoir and Correspondence of the Late Sir James Edward Smith, edited by Lady Smith*. 2 vols. (London, 1832).
- Thaer, Albrecht Daniel, *Einleitung zur Kenntniss der Englischen Landwirtschaft [...]* 3 vols. (Hannover, 1798–1804).
- Thaer, Albrecht Daniel, *Grundsätze der rationellen Landwirthschaft*. 4 vols. (Berlin, 1809–12).
- [Thaer, Albrecht Daniel], *Descriptions des nouveaux instrumens d'agriculture les plus utiles par A. Thaer. Traduit de l'allemand par C.-J.-A. Mathieu de Dombasle [...]* (Paris, 1821).
- [Thaer, Albrecht Daniel], *The Principles of Practical Agriculture by Albert D. Thaer; translated by William Shaw and Cuthbert W. Johnson* (New York, 1856).
- The Farmer's Magazine* Vol. 7 (July–December 1837).
- The Correspondence of the Right Honourable Sir John Sinclair, Bart.* 2 vols. (London, 1831).
- Townsend, Joseph, *A Journey through Spain in the Years 1786 and 1791*. 3 vols. (London, 1792).
- Tull, Jethro, *The New Horse-Houghing Husbandry or, an Essay on the Principles of Tillage and Vegetation* (Dublin, 1731).
- Turbilly, Louis-François-Henri de, *Mémoire sur les défrichements* (Amsterdam, 1762).
- Villermé, Louis, *L'Agriculture française: Mathieu de Dombasle, sa vie, ses œuvres, son influence* (Paris, 1864).
- Voltaire, M.-A. Goujon, *Oeuvres complètes de Voltaire*. Tome 7: *Dictionnaire philosophique* (Paris, 1817).
- Wollstonecraft, Mary, *Letters Written during a Short Residence in Sweden, Norway and Denmark* (London, 1796).
- Wulffen, Carl von, *Versuch einer Theorie über das Verhältniss der Ernten zu dem Vermögen und der Kraft des Bodens, über seine Bereicherung und Erschöpfung* (Berlin, 1815).
- Wulffen, Carl von, 'Sendschreiben an den Herrn Staatsrath Thaer über die Statik des Landbaues'. *Möglinische Annalen der Landwirtschaft* Vol. 2 (1818): 238–65.
- Young, Arthur, *A Course of Experimental Agriculture containing an exact Register of all the business Transacted during Five Years on near Three Hundred Acres of Various Soils including a variety of Experiments on the Cultivation of all Sorts of Grain and Pulse, both in the Old and the New Methods [...]* 2 vols. (London, 1770).
- Young, Arthur, *Travels during the Years 1787, 1788, and 1789, undertaken more particularly with a View of ascertaining the Cultivation, Wealth, Resources, and National Prosperity of the Kingdom of France*. 2 vols. (Bury-St Edmunds, 1792 and Dublin, 1793).
- Young, Arthur, *The Question of Scarcity plainly stated, and Remedies considered* (London, 1800).
- [Young, Arthur], *A View of the Agriculture of Oxfordshire. Drawn up for the Board of Agriculture and Internal Improvement* (London, 1809).
- [Young, Arthur], *Arthur Young's Travels in France during the Years 1787, 1788, 1789* (Betham-Edwards edition, London, 1900).

[Young, Arthur], *The Autobiography of Arthur Young edited by M. Betham-Edwards* (New York, 1967 [1st edn London, 1898]).

Websites

<http://www.oeg.hist.unibe.ch>
<http://www.lse.ac.uk/economicHistory/workingPapers>
<http://www.ruralhistory2013.org>
<http://www.shz.de>
<http://sok.riksarkivet.se/sbl/Presentation.aspx?id=20169>
http://algonet.se/~sylv_a/engelt_a.htm
<http://digibiblio.unibe.ch/digibern>
<http://Kartoffeltysker.dk>
www.lexilogos.com/famille/index_jackson.htm

Secondary Sources

- Abel, Wilhelm, *Agrarkrisen und Agrarkonjunktur: eine Geschichte der Land- und Ernährungswirtschaft Mitteleuropas seit dem hohen Mittelalter* (Hamburg and Berlin, 1966).
- Adams, Ian H., 'The Agents of Agricultural Change'. In *The Making of the Scottish Countryside*, edited by Martin L. Parry and Terry R. Slater (London, 1980), pp. 155–75.
- Albertone, Manuela, 'The American Agricultural Societies and the Making of the New Republic, 1785–1830'. In *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America* (London, 2012), pp. 339–69.
- Alimento, Antonella, *Réformes fiscales et crises politiques dans la France de Louis XV: de la taille tarifée au cadastre général* (Brussels, 2008).
- Allan, D. G. C. and Abbott, John L. (eds), *The Virtuoso Tribe of Arts and Sciences: Studies in the Eighteenth-Century Work and Membership of the London Society of Arts* (Athens, Georgia, 1992).
- Allen, Robert C., *Enclosure and the Yeoman* (Oxford, 1992).
- Allen, Robert C., 'Tracking the Agricultural Revolution in England'. *Economic History Review* vol. 52 no. 2 (May 1999): 209–35.
- Allen, Robert C., 'Economic Structure and Agricultural Productivity in Europe, 1300–1800'. *European Review of Economic History* vol. 4 no. 1 (2000): 1–26.
- Allen, Robert C., *The British Industrial Revolution in Global Perspective* (Cambridge, 2009).
- Allen, Robert C. and Ó Gráda, Cormac, 'On the Road again with Arthur Young: English, Irish, and French Agriculture during the Industrial Revolution'. *The Journal of Economic History* vol. 48 no. 1 (March 1988): 93–116.
- Ambrosoli, Mauro, *The Wild and the Sown: Botany and Agriculture in Western Europe, 1350–1850* (Cambridge, 1997).
- Astigarraga, Jesús and Usoz, Javier (eds), *L'Economie politique et la sphère publique dans le débat des Lumières* (Collection de la Casa Velázquez no. 135, Madrid, 2013).
- Atwater, Wilbur O., 'Sketch of Julius Adolph Stöckhardt'. *The Popular Science Monthly* vol. 19 (June 1881): 261–4.
- Baack, Lawrence J., 'State Service in the Eighteenth Century: The Bernstorffs in Hanover and Denmark'. *The International History Review* vol. 1 no. 3 (July 1979): 323–48.
- Bahar, Saba, 'Jane Marcet and the Limits to Public Science'. *British Journal for the History of Science* vol. 34 no. 1 (March 2001): 29–49.
- Barrell, John, *The Idea of Landscape and the Sense of Place 1730–1840: An Approach to the Poetry of John Clare* (Cambridge, 1972).

- Bartlett, Roger, *Human Capital: The Settlement of Foreigners in Russia, 1762–1804* (Cambridge, 1979).
- Barton, Hildor A., *Scandinavia in the Revolutionary Era, 1760–1815* (Minnesota, 1986).
- Barton, Hildor A., *Essays on Scandinavian History* (Carbondale, IL, 2009).
- Bartyś, Julian, 'English and Scottish Farmers in Poland in the First Half of the 19th Century'. *The Agricultural History Review* vol. 15 (1967): 88–102.
- Bates, Helen, 'Some Notes on Thomas Mante (alias "Junius"?). *Journal of Modern History* vol. 4 (1932): 232–4.
- Bavel, Bas J. P. van and Thoen, Erik (eds), *Land Productivity and Agro-Systems in the North Sea Area (Middle Ages—20th Century): Elements for Comparison* (Turnhout, 1999).
- Béaur, Gérard, *Histoire agraire de la France au XVIII^e siècle* (Paris, 2000).
- Becchia, Alain, *Modernités de l'Ancien Régime, 1750–1789* (Rennes, 2012).
- Beckett, John V., *The Aristocracy of England, 1660–1914* (Oxford, 1986).
- Beckett, John V., 'Estate Management in Eighteenth-Century England: The Lowther-Spedding Relationship in Cumberland'. In *English Rural Society, 1500–1800: Essays in Honour of Joan Thirsk*, edited by John Charters and David Hey (Cambridge, 1990), pp. 55–72.
- Bensaude-Vincent, Bernadette and Blondel, Christine (eds), *Science and Spectacle in the European Enlightenment* (Farnham, 2008).
- Berend, Ivan T., *An Economic History of Nineteenth-Century Europe: Diversity and Industrialisation* (Cambridge, 2013).
- 'Betteraves et sucre: une contribution majeure à l'économie agricole champardennaise'. *Agreste Champagne-Ardenne* vol. 6 (May 2009), i, <http://www.draaf.champagne-ardenne.agriculture.gouv.fr>, accessed 5 July 2015.
- Betty, Joseph, 'George Boswell of Puddletown (1735–1815): Progressive Farmer and Author'. *The Agricultural History Review* vol. 57 (2009): 58–69.
- Bickerton, David, *Marc-Auguste and Charles Pictet: The Bibliothèque britannique, 1796–1815 and the Dissemination of British Literature and Science on the Continent* (Geneva, 1986).
- Bieleman, Jan, *Five Centuries of Farming: A Short History of Dutch Agriculture, 1500–2000* (Mansholt Publication Series vol. 8, Wageningen, 2010).
- [Binns, Sir Bernard O.], *The Consolidation of Fragmented Agricultural Holdings: An FAO Study Prepared by Sir Bernard O. Binns* (Washington, 1950).
- Björn, Claus, 'The Study of the Agrarian History of Denmark: A Brief Introduction to the Literature'. *The Agricultural History Review* vol. 22 no. 1 (1974): 50–3.
- Björn, Claus, 'The Peasantry and Agrarian Reform in Denmark'. *Scandinavian Economic History Review* vol. 25 (1977): 117–37.
- Black, Jeremy, *The Power of Knowledge: How Information and Technology Made the Modern World* (New Haven, CT and London, 2014).
- Blackbourn, David, *The Conquest of Nature: Water, Landscape and the Making of Modern Germany* (London, 2007).
- Blanning, Tim C. W., *The Culture of Power and the Power of Culture: Old Regime Europe, 1660–1789* (Oxford, 2002).
- Bleton-Ruget, Annie, 'La Paysannerie en débat: autour du décret du 3 octobre 1848 sur l'enseignement agricole'. In *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945. Actes du colloque ENESAD, 19–21 janvier 1999*, edited by Michel Boulet (Dijon, 2000), pp. 45–53.
- Bloch, Marc, *Les Caractères originaux de l'histoire rurale française*. 2 vols. (Paris, 1952, 1956).
- Blum, Jerome, *The End of the Old Order in Rural Europe* (Princeton, NJ, 1978).
- Bödeker, Hans E., '“Sehen, hören, sammeln, schreiben”. Gelehrte Reisen im Kommunikationssystem der Gelehrtenrepublik'. *Pedagogica Historica* vol. 38 nos. 2–3 (2002): 505–32.

- Bödeker, Hans E., 'Economic Societies in Germany, 1760–1820: Organisation, Social Structures and Fields of Activities'. In *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, edited by Koen Stapelbroek and Jani Marjanen (London, 2012), pp. 182–211.
- Bonnyman, Brian, 'Agrarian Patriotism and the Landed Interest: The Scottish "Society of Improvers in the Knowledge of Agriculture", 1723–1746'. In *The Rise of Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, edited by Koen Stapelbroek and Jani Marjanen (London, 2012), pp. 26–51.
- Borsay, Peter, 'The Culture of Improvement'. In *The Eighteenth Century, 1688–1815*, edited by Paul Langford (Oxford, 2002), pp. 183–212.
- Boserup, Ester, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (London, 1993 [1st edn. 1965]).
- Boud, R. C., 'Scottish Agricultural Improvement Societies, 1723–1835'. *Review of Scottish Culture* vol. 1 (1984): 70–90.
- Boulaine, Jean, *Histoire de l'agronomie en France*. 2nd edn. (Paris, 1996).
- Boulet, Michel (ed.), *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945. Actes du colloque ENESAD, 19–21 janvier 1999* (Dijon, 1999).
- Bourde, André-Jean, *The Influence of England on the French Agronomes* (Cambridge, 1953).
- Bourde, André-Jean, *Agronomie et agronomes en France au XVIII^e siècle*. 3 vols. (Paris, 1967).
- Bourrigaud, René, *Le Développement agricole au 19^e siècle en Loire-Atlantique* (Nantes, 1994).
- Bradley, Joseph, *Voluntary Associations in Tsarist Russia: Science, Patriotism, and Civil Society* (Cambridge, MA, 2009).
- Braunstein, Philippe and Landsteiner, Erich, 'The Production and Trade of Steel and Steel Tools in the Early Modern Semi-Periphery: A Commodity Chain Approach to the Innerberg District (Austria) in the 16th and 17th Centuries'. In *L'Acier en Europe avant Bessemer*, edited by Philippe Dilmann, Liliane Pérez, and Catherine Verna (Toulouse, 2011), pp. 405–46.
- Broad, John, 'The Verneys as Enclosing Landlords, 1600–1800'. In *English Rural Society, 1500–1800: Essays in Honour of Joan Thirsk*, edited by John Charters and David Hey (Cambridge, 1990), pp. 27–53.
- Broad, John (ed.), 'A Common Agricultural Heritage? Revising French and British Rural Divergence'. *The Agricultural History Review Supplement*, Series 5 (British Agricultural History Society, 2009).
- Broadberry, Stephen N., 'Accounting for the Great Divergence', 18 August 2014, <http://www.lse.ac.uk/economicHistory/pdf/>, accessed 21 July 2015.
- Broadberry, Stephen, Campbell, Bruce M. S., Klein, Alexander, Overton, Mark, Leeuwen, Bas van, *British Economic Growth, 1270–1870* (Cambridge, 2015).
- Brooke Hindle, *Emulation and Invention* (New York, 1981).
- Brossault, Colette, *Les Intendants de Franche-Comté, 1674–1790* (Paris, 1999).
- Bruland, Kristine, 'New Technologies and the Industrial Revolution'. In *Artisans, industrie: nouvelles révolutions du Moyen Âge à nos jours*, edited by Natasha Coquery, Liliane Hilaire-Pérez, Line Sallman, and Catherine Verna (Lyon, 2004), pp. 55–68.
- Brunet, Guy, *Population et environnement: Vie et mort dans la Dombes des étangs aux XVIII^e et XIX^e siècles* (Berne, 2011).
- Brunt, Liam, 'The Advent of the Sample Survey in the Social Sciences'. *Journal of the Royal Statistical Society Series D*, vol. 50 (2001): 179–89.
- Brunt, Liam, 'Mechanical Innovation in the Industrial Revolution: The Case of Plough Design'. *The Economic History Review* vol. 56 no. 3 (August 2003): 444–77.

- Brunt, Liam, 'Rehabilitating Arthur Young'. *The Economic History Review* vol. 56 no. 2 (May 2003): 265–99.
- Bruyn, Frans de, 'From Georgic Poetry to Statistics and Graphs: Eighteenth-Century Representations and the "State" of British Society'. *The Yale Journal of Criticism* vol. 17 no. 1 (2004): 107–39.
- Busch, Björn, *Die Flurbereinigung von Weinbergflächen an der Mittelmose zwischen Bernkastel-Kues und Traben-Trarbach* (Grin Verlag e-book, 2008).
- Butrica, Andrew J., 'Collections in Jeopardy: The Société d'Encouragement pour l'Industrie Nationale'. *Isis* vol. 88 no. 2 (June 1997): 296–301.
- Buyst, Erik, 'Estimates of Economic Growth in the Southern Low Countries / Belgium c.1770–1846', <http://dev3.cepr.org>, accessed 20 May 2014.
- Campbell, Bruce M. S. and Overton, Mark (eds), *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity* (Manchester, 1991).
- Campbell, R. H., 'The Enlightenment and the Economy'. In *The Origins and Nature of the Scottish Enlightenment*, edited by R. H. Campbell and Andrew S. Skinner (Edinburgh, 1982), pp. 8–25.
- Cantelaube, Jean, 'L'Acérie, usine à faux et limes du Bazacle: Toulouse, ville pionnière d'une industrie nouvelle au XIX^e siècle'. In *Toulouse, une métropole méridionale: vingt siècles de vie urbaine*, edited by Bernadette Suau, Jean-Pierre Amalric, and Jean-Marc Olivier. 2 vols. (Toulouse, 2009), i, pp. 503–15.
- Carillon, Rémi, 'Du baton à fouir à l'aube de la motorisation agricole' [1986], <http://documents.irevues.inist.fr>, accessed 23 February 2015.
- Carmona, Juan and Simpson, James, 'The "Rabassa Morta" in Catalan Viticulture: the Rise and Decline of a Long-term Sharecropping Contract, 1670s–1920s'. *The Journal of Economic History* vol. 59 no. 2 (June 1999): 290–315.
- Cerman, Markus, 'Rural Economy and Society'. In *A Companion to 18th Century Europe*, edited by Peter H. Wilson (Oxford, 2008), pp. 47–65.
- Chaldecott, John A., 'Scientific Activities in Paris in 1791: Evidence from the Diaries of Sir James Hall for 1791, and other Contemporary Records'. *Annals of Science* vol. 24 no. 1 (1968): 21–52.
- Chalmel, Loïc, *Oberlin le Pasteur des Lumières* (Strasbourg, 2006).
- Champouillon, Jacques, *Roville devant Bayon : histoire d'un village lorrain, berceau de la première école d'agriculture de France* (chez l'auteur, n. d. [2001]).
- Chapman, Dennis, 'Richard Clyburn, Agricultural Engineer, and the Uley Cultivator'. *Gloucestershire Society for Industrial Archaeology Journal* (1998): 59–61.
- Charmasson, Thérèse, Lelorrain, Anne-Marie, and Ripa, Yannick, *L'Enseignement agricole et vétérinaire de la Révolution à la Libération* (Paris, 1992).
- Chassagne, Serge, 'Une Institution originale de la France post-révolutionnaire et impériale: la Société d'encouragement pour l'industrie nationale'. *Histoire, économie, société*, 8^e année no. 2 (1989): 147–65.
- Chevet, Jean-Michel, *La Terre et les paysans en France et en Grande-Bretagne: Du début du XVII^e siècle à la fin du XVIII^e siècle*, vol. 1: *Les Hommes et les structures foncières*; vol. 2: *Les Hommes et la production* (Paris, 1998).
- Chevet, Jean-Michel, 'La transmission des savoirs agricoles dans les processus de croissance aux XVIII^e–XIX^e siècles: l'exemple de la région parisienne'. In *Traditions agronomiques européennes. Actes du 120^e congrès national des sociétés historiques et scientifiques. Aix-en-Provence, 1995*, edited by Marie-Claire Amouretti and François Sigaut (Paris, 1998), pp. 181–96.

- Chiffre, Jean, 'Métrologie et parcellaire en Bourgogne au XVIII^e siècle'. *Cahiers de métrologie* vol. 4 (1986): 3–18.
- Chorley, G. Patrick H., 'The Agricultural Revolution in Northern Europe, 1750–1850: Nitrogen, Legumes, and Crop Productivity'. *Economic History Review* vol. 34 no. 1 (1981): 71–93.
- Chorley, G. Patrick H., 'The Shift from Spanish to Central European Merino Wools in the Verviers–Aachen Cloth Industry'. In *Textiles in the Low Countries in European Economic History*, edited by Erik Aerts (Leuven, 1990), pp. 96–104.
- Christen, Carole and Vatin, François (eds), *Charles Dupin (1783–1873): ingénieur, savant, économiste, pédagogue et parlementaire du Premier au Second Empire* (Rennes, 2009).
- Christensen, Dan Ch. (ed.), *European Historiography of Technology. Proceedings from the TTSC-Conference in Roskilde* (Odense, 1993).
- Christensen, Dan Ch., *Det Moderne Projekt: Teknik & Kultur i Danmark-Norge, 1750–(1814)–1850* (Copenhagen, 1996).
- Christensen, Dan Ch., 'Estimating Arable Production and Productivity in Danish Agriculture during the Age of Reform, 1750–1850'. In *Land Productivity and Agro-Systems in the North Sea Area (Middle Ages—20th Century): Elements for Comparison*, edited by Bas J. P. van Bavel and Erik Thoen (Turnhout, 1999), pp. 168–88.
- Christensen, Dan Ch., 'Physiocracy—the Missing Link?' In *Modernisation and Tradition: European Local and Manorial Societies 1500–1900*, edited by Kerstin Sundberg, Tomas Germundsson, and Kjell Hansen (Lund, 2004), pp. 78–106.
- Christiansen, Palle O., *A Manorial World: Lords, Peasants and Cultural Distinctions on a Danish Estate, 1750–1980* (Oslo, Copenhagen, Stockholm, Oxford, Boston, 1996).
- Clark, Gregory, 'Commons Sense: Common Property Rights, Efficiency, and Institutional Change'. *The Journal of Economic History* vol. 58 no. 1 (1998): 73–102.
- Clout, Hugh D., *The Land of France 1815–1914* (London, 1983).
- Clout, Hugh D. and Phillips, A. D. M., 'Sugar-Beet Production in the Nord Département of France during the Nineteenth Century'. *Erdkunde* vol. 27 (1973): 105–19.
- Cocaud, Martine, 'Des cadres pour la rénovation agricole: les sociétés d'agriculture en Ille-et-Vilaine en 1757–1880'. In *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945*, edited by Michel Boulet (Dijon, 2000), pp. 1–52.
- Collins, E. J. T., 'The Diffusion of the Threshing Machine in Britain, 1790–1880'. *Tools and Tillage* vol. 2 (1972): 16–33.
- Collins, E. J. T. (ed.), *The Agrarian History of England and Wales*, vol. 7: 1850–1914 (Part 1) (Cambridge, 2000).
- [Collins, E. J. T.], 'Change and Continuity in the Manufacture of Agricultural Edge-tools. Version 16.6.08' <http://www.lse.ac.uk/economicHistory/seminars/.../PAPER-Collins.pdf>, accessed 20 May 2014.
- Connel, Kenneth H., 'The Colonisation of Waste Land in Ireland, 1780–1845'. *The Economic History Review* vol. 3 no. 1 (1950): 44–71.
- Conze, Werner (ed.), *Quellen zur Geschichte der deutschen Bauernfreierung* (Göttingen, 1957).
- Conze, Werner, 'The Effects of Nineteenth-Century Liberal Agrarian Reforms on Social Structure in Central Europe'. In *Essays in European Economic History, 1789–1914*, edited by François M. J. Crouzet, William H. Challoner, and W. M. Stern (London, 1969), pp. 53–81.
- Cross, Anthony G., *'By the Banks of the Thames': Russians in Eighteenth-Century Britain* (Newtonville, MA, 1980).
- Crotty, Raymond, D., *Irish Agricultural Production: Its Volume and Structure* (Cork, 1966).

- Crouzet, François M. J., Chaloner, William H., and Stern, W. M. (eds), *Essays in European Economic History, 1789–1914* (London, 1969).
- Crowther, Edward M. 'The Technique of Modern Field Experiments'. *Journal of the Royal Agricultural Society of England* vol. 97 (1936): 54–81.
- Davidson, Neil, 'The Scottish Path to Capitalist Agriculture 1: From the Crisis of Feudalism to the Origins of Agrarian Transformation (1688–1746)'. *Journal of Agrarian Change* vol. 4 no. 3 (2004): 227–68.
- Davidson, Neil, 'The Scottish Path to Capitalist Agriculture 2: The Capitalist Offensive (1747–1815)'. *Journal of Agrarian Change* vol. 4 no. 4 (2004): 411–60.
- Davidson, Neil, 'The Scottish Path to Capitalist Agriculture 3: The Enlightenment as the Theory and Practice of Improvement'. *Journal of Agrarian Change* vol. 5 no. 1 (2005): 1–72.
- Delleaux, Fulgence, 'Diffusion et application des méthodes culturales flamandes dans les anciens Pays Bas méridionaux au XVIII^e siècle: le témoignage de Jean-Baptiste Mondez fermier en Hainaut autrichien'. *Revue historique*, no. 653 (2010): 27–58.
- 'Der Mann der Knicks'. In *Storrmärner Tageblatt*, 12 February 2014.
- Devine, Tom, *The Transformation of Rural Scotland: Social Change and the Agrarian Economy, 1660–1815* (Edinburgh, 1994).
- Diederer, Paul, van Meijl, Hans, and Wolters, Arjan, 'Innovation Adoption in Agriculture: Innovators, Early Adopters and Laggards'. *Cahiers d'économie et sociologie rurales* vol. 67 (2003): 30–50.
- Dillmann, Philippe, Pérez, Liliane, and Verna, Catherine (eds), *L'Acier en Europe avant Bessemer* (Toulouse, 2011).
- Dodgshon, Robert A., *Society in Time and Space: A Geographical Perspective on Change* (Cambridge, 1998).
- Dovring, Folke, *Land and Labour in Europe in the Twentieth Century: A Comparative Survey of Recent Agrarian History. With a Chapter on Land Reform as a Propaganda Theme by Karin Dovring* (The Hague, 1965).
- Drayton, Richard, *Nature's Government: Science, Imperial Britain, and the Improvement of the World* (New Haven, CT, 2000).
- Dudley, Leonard, *Mothers of Invention: How Expanding Social Networks Gave Birth to the Industrial Revolution* (Newcastle upon Tyne, 2012).
- Eck, Jean-François, and Tilly, Pierre (eds), *Innovations et transferts de technologie en Europe du Nord-Ouest aux XIX^e et XX^e siècles* (Brussels, 2011).
- Ellen, Roy, *Environment, Subsistence and System: The Ecology of Small-Scale Social Formations* (Cambridge, 1982).
- Ellison, Glenn, and Fudenberg, Drew, 'Rules of Thumb for Social Learning'. *Journal of Political Economy* vol. 101 no. 4 (1993): 612–43.
- Emery, F., 'The Mechanics of Innovation: Clover Cultivation in Wales before 1720'. *Journal of Historical Geography* vol. 2 no. 1 (1976): 35–48.
- Engelhardt, Julian, 'Patriotic Societies and the Royal Imperial Reforms in Denmark, 1761–1814'. In *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, edited by Koen Stapelbroek and Jani Marjanen (London, 2012), pp. 212–32.
- EU Agricultural Economics Briefs*, vol. 8 (July 2013): 1–17. <http://ec.europa.eu>, accessed 29 July 2015.
- Faccarello, Gilbert (ed.), *Studies in the History of French Political Economy: From Bodin to Walras* (New York, 1998).
- Feder, Gershon, Just, Richard E., and Zilberman, David, 'Adoption of Agricultural Innovations in Developing Countries: A Survey'. *Economic Development and Cultural Change* vol. 33 no. 2 (1985): 225–98.

- Federico, Giovanni, *Feeding the World: An Economic History of Agriculture, 1800–2000* (Princeton, NJ, 2005).
- Federico, Giovanni, 'The Corn Laws in Continental Perspective'. *European Review of Economic History* vol. 16 no. 2 (2012): 166–87.
- Feller Christian L., Thuriès, Laurent J.-M., Manlay, Raphaël J., Robin, Paul, and Frossard, Emmanuel, "The Principles of Rational Agriculture" by Albrecht Thaer (1752–1828): An Approach to the Sustainability of Cropping Systems at the Beginning of the 19th Century'. *Journal of Plant Nutrition* vol. 166 no. 6 (2003), 687–98. doi 10.1002/jpln.200321233.
- Fillon, Anne, *Louis Simon villageois de l'ancienne France* (Rennes, 1996).
- Finlay, Mark R., 'The German Agricultural Experiment Stations and the Beginnings of American Agricultural Research'. *Agricultural History* vol. 62 no. 2 (1988): 41–50.
- Finlay, Mark R., 'The Rehabilitation of an Agricultural Chemist: Justus von Liebig and the Seventh Edition'. *Ambix* vol. 38 (1991): 155–67.
- Finzi, Roberto (ed.), *Fra Studio, politica ed economica: la Società Agraria dalle origini all'età giolittiana. Atti de 6° Convegno. Bologna, 13–15 dicembre 1990* (Bologna, 1992).
- Flatrès, Huguette and Pierre, 'Mutations agricoles et transformations des paysages en Europe'. *Noréis* vol. 44 (1997): 173–93.
- Follain, Antoine (ed.), *Une Société agronome au XVIII^e siècle, les Thesmophores de Blaison en Anjou* (Dijon, 2010).
- Fontaine, Philippe, 'Le Concept d'industrie au XVIII^e siècle: à la recherche d'une acceptation oubliée'. *Economies et sociétés* vol. 26 no. 3 (March 1992): 7–33.
- Forman, Paul, 'The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology'. *History and Technology* vol. 23 nos 1–2 (2007): 1–152.
- Fors, Hjalmar, *Mutual Favours: The Social and Scientific Practice of Eighteenth-Century Swedish Chemistry* (Uppsala, 2003).
- Fowler, Richard H., *Robert Burns* (London, 1988).
- Fox, Robert (ed.), *Technological Change: Methods and Themes in the History of Technology* (Amsterdam, 1996).
- Friedmann, Karen J., 'Bureaucracy, Land Reform, and Technological Progress: Denmark, 1755–1810'. *Food Research Studies* vol. 17 no. 2 (1979): 219–34.
- Friedmann, Karen J., 'Fencing, Herding, and Tethering in Denmark, from Open-Field Agriculture to Enclosure'. *Agricultural History* vol. 58 no. 4 (1984): 584–97.
- Fussell, George E., 'The Technique of Early Field Experiments'. *Journal of the Royal Agricultural Society of England* vol. 96 (1935): 78–88.
- Fussell, George E., 'My Impressions of Arthur Young'. *Agricultural History* vol. 17 no. 3 (July 1943): 135–44.
- Fussell, George E., 'Science and Practice in Eighteenth-Century British Agriculture'. *Agricultural History* vol. 43 no. 1 (1963): 7–18.
- Fussell, George E., 'Ploughs and Ploughing before 1800'. *Agricultural History* vol. 40 no. 3 (July 1966): 177–86.
- Gadd, Carl-Johan, 'The Agricultural Revolution in Sweden, 1700–1870'. In *The Agrarian History of Sweden: 4000 BC to AD 2000*, edited by Janken Myrdal and Mats Morell (Lund, 2011), pp. 118–64.
- Gascoigne, John, *Science, Philosophy and Religion in the Age of the Enlightenment: British and Global Contexts* (Farnham, 2010).
- Gazley, John G., *The Life of Arthur Young 1741–1820* (Philadelphia, 1973).

- Germundsson, Tomas, 'Mackleans bokhylla'. In *Geografi i Lund: essäer tillägnade Gunnar Törnqvist*, edited by Kerstin Cederlund, Tora Friberg, and Maria Wikhall (Lund, 1999), pp. 56–63.
- Germundsson, Tomas, 'Landscape and Modernity'. In *Modernisation and Tradition. European Local and Manorial Societies 1500–1900*, edited by Kerstin Sundberg, Tomas Germundsson, and Kjell Hansen (Lund, 2004), pp. 190–221.
- Gille, Bertrand, *Les Sources statistiques de l'histoire de la France: Des enquêtes du XVIII^e siècle à 1870* (Geneva and Paris, 1964).
- Gille, Bertrand (ed.), *The History of Techniques*. 2 vols. (New York, London and Tokyo, 1986).
- Gilligan, Jim, *Graziers and Grasslands: Portrait of a Rural Meath Community, 1854–1914* (Dublin, 1998).
- Goddard, Nicholas, '“Not a Reading Class”: the Development of the Victorian Agricultural Textbook'. *Paradigm: Journal of the Textbook Colloquium* vol. 23 (July 1997), <http://education.illinois.edu>, accessed 5 July 2015.
- Golinski, Jan, 'Joseph Priestley and the Chemical Sublime in British Public Science'. In *Science and Spectacle in the European Enlightenment*, edited by Bernadette Bensaude-Vincent and Christine Blondel (Aldershot, 2008), pp. 117–28.
- Goossens, Martine, *The Economic Development of Belgian Agriculture: A Regional Perspective, 1812–1846* (Brussels, 1992).
- Grab, Alexander, 'The Politics of Subsistence: The Liberalization of Grain Commerce in Austria Lombardy under Enlightened Despotism'. *Journal of Modern History* vol. 57 no. 2 (June 1985): 185–210.
- Grab, Alexander, 'Enlightened Absolutism and Commonlands Enclosure: The Case of Austrian Lombardy'. *Agricultural History* vol. 63 no. 1 (1989), 49–72.
- Grantham, George, 'The Diffusion of the New Husbandry in Northern France, 1815–1840'. *The Journal of Economic History* vol. 38 (June 1978): 311–37.
- Grantham, George, 'The Persistence of Open-Field Farming in Nineteenth-Century France'. *Journal of Economic History* vol. 40 (September 1980): 515–31.
- Grantham, George, 'The Growth of Labour Productivity in the Production of Wheat in the Cinq Grosses Fermes of France, 1750–1929'. In *Land, Labour and Livestock: Historical Studies of European Agricultural Productivity*, edited by Bruce M. S. Campbell and Mark Overton (Manchester, 1991), pp. 340–63.
- Grantham, George, 'La faucille et la faux: un exemple de dépendance temporelle'. *Etudes rurales* vol. 151 nos. 151–2 (1999): 103–31.
- Gray, Marion W., *Prussia in Transition: Society and Politics under the Stein Reform Ministry of 1808* (Philadelphia, 1986).
- Gray, Marion W. 'From Household Economy to “Rational Agriculture”: The Establishment of Liberal Ideals in German Agricultural Thought'. In *In Search of Liberal Germany: Studies in the History of German Liberalism from 1789 to the Present*, edited by Konrad H. Jarausch and Larry E. Jones (New York, 1990), pp. 25–54.
- Grigg, David B., *Population Growth and Agrarian Change: An Historical Perspective* (Cambridge, 1980).
- Grosclaude, Pierre, *Malesherbes: Témoin et interprète de son temps* (Paris, 1961).
- Guasti, Niccolò, 'Malesherbes' Civil Economy and the Emergence of the Public Sphere in Spanish *Ilustración*'. In *L'Economie politique et la sphère publique dans le débat des Lumières*, edited by Jesús Astigarraga and Javier Usoz (Collection de la Casa Velázquez no. 135, Madrid, 2013), pp. 229–44.

- Guilcher, André, 'Points de vue nouveaux sur la structure agraire de la Bretagne'. *L'Information géographique* vol. 10 no. 1 (1946): 9–15.
- Guillory aîné, Pierre-Constant, *Notice sur le Marquis de Turbilly, agronome angevin du XVIII^e siècle* (Angers, 1849).
- Hagen, William W., *Ordinary Prussians: Brandenburg Junkers and Villagers, 1500–1840* (Cambridge, 2002).
- Hall, A. Daniel, *The Book of the Rothamsted Experiments* (London, 1905).
- Hall, Vance, *A History of the Yorkshire Agricultural Society, 1837–1987* (London, 1987).
- Handley, James E., *The Agricultural Revolution in Scotland* (Glasgow, 1963).
- Harris, John R. 'Law, Espionage, and the Transfer of Technology from Eighteenth-Century Britain'. In *Technological Change: Methods and Themes in the History of Technology*, edited by Robert Fox (Amsterdam, 1996), pp. 122–35.
- Harris, John R., *Industrial Espionage and Technology Transfer: Britain and France in the Eighteenth Century* (Aldershot, 1998).
- Harwood, Jonathan, *Technology's Dilemma: Agricultural Colleges between Science and Practice in Germany, 1860–1934* (Bern, 2005).
- Hauben, Paul J. 'The First Decade of an Agrarian Experiment in Bourbon Spain'. *Agricultural History* vol. 39 no.1 (1965): 34–40.
- Heikkinen, Sakan, Heinonen, Visa, Kuusterä, Antti, and Pekkarinen, Jukka, *The History of Finnish Economic Thought 1809–1917. (The History of Learning and Science in Finland 1828–1917)* (Ekenäs, Finland, 2000).
- Helmfrid, Staffan, 'The Storskifte, Enskifte and Laga Skifte in Sweden: General Features'. *Geografiska Annaler* vol. 43 nos. 1–2 (1961): 114–29.
- Henderson, William O., *Britain and Industrial Europe, 1750–1870: Studies in British Influence on the Industrial Revolution in Western Europe* (Liverpool, 1954).
- Henderson, William O., *Friedrich List: Economist and Visionary, 1789–1846* (London, 1983).
- Herment, Laurent, *Les Fruits du Partage: petits paysans du Bassin Parisien au XIX^e siècle* (Rennes, 2012).
- Herr, Richard, *Rural Change and Royal Finances in Spain at the End of the Old Regime* (Berkeley and Los Angeles, 1989).
- Hilaire-Pérez Liliane, 'Technology as Public Culture in the Eighteenth Century: The Artisans' Legacy'. *History of Science* vol. 45 (2007), 135–53.
- Hilaire-Pérez, Liliane and Verna, Catherine, 'Dissemination of Technical Knowledge in the Middle Ages and the Early Modern Era: New Approaches and Methodological Issues'. *Technology and Culture* vol. 47 no. 3 (2006): 536–65.
- Hilton, Boyd, *Corn, Cash, Commerce: The Economic Policies of the Tory Governments 1815–1830* (Oxford, 1977).
- Holmes, Heather, 'The Circulation of Scottish Agricultural Books during the Eighteenth Century'. *The Agricultural History Review* vol. 54 no. 1 (2006): 45–78.
- Hont, Istvan, *Jealousy of Trade: International Competition and the Nation-State in Historical Perspective* (Cambridge, MA, 2005).
- Hoppe, Göran and Langton, John, *Peasantry to Capitalism: Western Östergötland in the Nineteenth Century* (Cambridge, 1994).
- Horn, Jeff and Jacob, Margaret C., 'Jean-Antoine Chaptal and the Cultural Roots of French Industrialization'. *Technology and Culture* vol. 39 no. 4 (October 1998): 671–98.
- Horne, Pamela, 'The Contribution of the Propagandist to Eighteenth-Century Agricultural Improvement'. *The Historical Review* vol. 25 no. 2 (1982): 313–29.

- Hottenger, Georges, *La Propriété rurale: morcellement et remembrement* (Paris and Nancy, 1914).
- Huttman, John P. 'The Impact of Land Reform on Agricultural Production in Ireland'. *Agricultural History* vol. 46 no. 3 (1972): 353–68.
- Imbruglia, Girolamo, 'Enlightenment in 18th Century Naples'. In *Naples in the Eighteenth Century: The Birth and Death of a Nation-State*, edited by Girolamo Imbruglia (Cambridge, 2000), pp. 70–94.
- Imbruglia, Girolamo (ed.), *Naples in the Eighteenth Century: The Birth and Death of a Nation-State* (Cambridge, 2000).
- Ingrao, Charles W., *The Hessian Mercenary State: Ideas, Institutions and Reform under Frederick II, 1760–1785* (Cambridge, 1987).
- Inkster, Ian, *Scientific Culture and Urbanisation in Industrialising Britain* (Aldershot, 1997).
- Jacob, Margaret C., and Stewart, Larry, *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687–1851* (Cambridge, MA, 2004).
- James, Patricia (ed.), *The Travel Diaries of Robert Malthus* (Cambridge, 1966).
- Jas, Nathalie, *Au Carrefour de la chimie et de l'agriculture: les sciences agronomiques en France et en Allemagne, 1850–1914* (Paris, 2000).
- Jones, D. W., 'The Workings and Measurement of Pre-Industrial "Organic" Economies: Conjectures on English Agrarian Growth, 1660–1820'. *The Journal of Economic History* vol. 35 no. 1 (2006): 177–218.
- Jones, Eric L., *Locating the Industrial Revolution: Inducement and Response* (Singapore, 2010).
- Jones, Jean, 'James Hutton's Agricultural Research and his Life as a Farmer. *Annals of Science* vol. 42 (1985): 573–601.
- Jones, Peter M. 'Common Rights and Agrarian Individualism in the Southern Massif Central 1750–1880'. In *Beyond the Terror: Essays in French Regional and Social History, 1794–1815*, edited by Gwynne Lewis and Colin Lucas (Cambridge, 1983), pp. 121–51.
- Jones, Peter M., *The Peasantry in the French Revolution* (Cambridge, 1988).
- Jones, Peter M., *Liberty and Locality in Revolutionary France: Six Villages Compared, 1760–1820* (Cambridge, 2003).
- Jones, Peter M., *Industrial Enlightenment: Science, Technology and Culture in Birmingham and the West Midlands, 1760–1820* (Manchester, 2008, 2013).
- Jones, Peter M. "'Commerce des Lumières": the International Trade in Technology, 1763–1815'. *Quaderns d'història de l'enginyeria* vol. 10 (2009): 67–82.
- Jones, Peter M., 'Arthur Young (1741–1820): For and Against'. *English Historical Review* vol. 127 no. 528 (October 2012): 1041–62. doi: 10.1093/her/ces209.
- Jones, Peter M., 'The Challenge of Land Reform in Eighteenth- and Nineteenth-Century France'. *Past & Present* no. 216 (August 2012): 107–42.
- Jones, Peter M., 'Agriculture'. In *The Oxford History of the Ancien Régime*, edited by William Doyle (Oxford, 2014), pp. 236–51.
- Juchau, Roger, 'Early Cost Accounting Ideas in Agriculture: The Contributions of Arthur Young'. *Accounting, Business & Financial History* vol. 12 no. 3 (2002): 369–86. doi 10.1080/09585200210164566.
- Justin, Emile, *Les Sociétés royales d'agriculture au XVIII^e siècle (1757–1793)* (Saint Lô, 1935).
- Kain, Roger J. P. and Baigent, Elizabeth, *The Cadastral Map in the Service of the State: A History of Property Mapping* (Chicago, 1992).
- Kalm's Account of his Visit to England on his Way to America in 1748*. Translated by Joseph Lucas (London, 1892).

- Kay, George, 'The Landscape of Improvement: A Case Study of Agricultural Change in North East Scotland'. *Scottish Geographical Magazine* vol. 78 no. 2 (1962): 100–11.
- Kerridge, Eric, *The Agricultural Revolution* (London, 1967).
- Kerridge, Eric, *The Farmers of Old England* (London, 1973).
- Kington, John A., 'Daily Weather Mapping from 1781: A Detailed Synoptic Examination of Weather and Climate during the Decade Leading up to the French Revolution'. *Climatic Change* vol. 3 no. 1 (1980): 7–36.
- Kjaergaard, Thorkild, *The Danish Revolution, 1500–1800: An Ecobistorical Interpretation* (Cambridge, 1994).
- Klein, Ursula, 'Artisanal-Scientific Experts in Eighteenth-Century France and Germany'. *Annals of Science* vol. 69 no. 3 (July 2012): 303–6. doi 10.1080/00033790.2012.675195.
- Klein, Ursula, 'Savant Officials in the Prussian Mining Administration'. *Annals of Science* vol. 69 no. 3 (July 2012): 349–74. doi 10.1080/00033790.2012.673234.
- Knudsen, Daniel C. and Greer, Charles E., 'Heritage Tourism, Heritage Landscapes and Wilderness Preservation: The Case of National Park Thy'. *Journal of Heritage Tourism* vol. 3 no. 1 (2008): 18–31.
- Konieczna, Ewe, 'The Influence of the British Pattern on the Agricultural Work of Dezydery Chłapowski'. *Polish-Anglosaxon Studies* vol. 2 (1991): 69–78.
- Koning, Nick, *The Failure of Agrarian Capitalism: Agrarian Politics in the UK, Germany, the Netherlands and the USA, 1846–1919* (London and New York, 1994).
- Kopsidis, Michael and Hockmann, Heinrich, 'Technical Change in Westphalian Peasant Agriculture and the Rise of the Ruhr circa 1830–1880'. *European Review of Economic History* vol. 14 no. 2 (August 2010): 209–37. doi 10.1017/S1361491610000018.00.
- Kopsidis, Michael and Pfister, Ulrich, 'Agricultural Development during Early Industrialization in a Low-Wage Economy: Saxony, c.1790–1830'. *EHES Working Papers* vol. 39 (June 2013): iii–148.
- Kopsidis, Michael and Wolf, Nikolaus, 'Agricultural Productivity across Prussia during the Industrial Revolution: A Thünen Perspective'. *The Journal of Economic History* vol. 72 (2012): 634–70.
- Korshin, Paul J. (ed), *The Widening Circle: Essays on the Circulation of Literature in Eighteenth-Century Europe* (University Park, PA, 1976).
- Kronick, David A., *A History of Scientific and Technical Periodicals: The Origins and Development of the Scientific and Technical Press, 1665–1790* (Metuchen, NJ, 1976).
- Kulhawy, Andreas, 'Financing the Agrarian Reforms and Promoting the Modernisation of Farming in 19th Century Germany: The Example of the Duchy of Brunswick'. In *The State and Rural Societies: Policy and Education in Europe, 1750–2000*, edited by Nadine Vivier (Turnhout, 2008).
- Kussmaul, Ann, *A General View of the Rural Economy of England, 1538–1840* (Cambridge, 1990).
- La Rochefoucauld, Jean-Dominique, Wolikow, Claudine, and Ikni, Guy-Robert, *Le Duc de La Rochefoucauld-Liancourt: 1747–1827. De Louis XV à Charles X, un grand seigneur patriote et le mouvement populaire* (Paris, 1980).
- Lachaud, S. 'Les Conflits liés aux droits féodaux et seigneuriaux en Sauternais aux XVII^e et XVIII^e siècles'. In *Les Elites de la terre du XVI^e siècle aux années 1930*, edited by Caroline Le Mao and Corinne Marache (Paris, 2010), pp. 77–100.
- Lagadec, Yann, 'Comice cantonale et acculturation agricole: l'exemple de l'Ille-et-Vilaine au XIX^e siècle'. *Ruralia* vol. 9 (2001): 1–56.
- Landes, David S., *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge, 1969, 2003).

- Laudan, Rachel, 'Natural Alliance or Forced Marriage? Changing Relations between the Histories of Science and Technology'. *Technology and Culture* vol. 36 no. 2 (1995), Supplement: 17–30.
- Le Mao, Caroline and Marache, Corinne, (eds), *Les Elites et la terre du XVI^e siècle aux années 1930* (Paris, 2010).
- Leask, Nigel, *Robert Burns and the Pastoral: Poetry and Improvement in Late Eighteenth-Century Scotland* (Oxford, 2010).
- Lebeau, René, *Les Grands types de structures agraires dans le monde* (Paris, 1969).
- Lenman Bruce P., *Enlightenment and Change: Scotland, 1746–1832*. 2nd edn. (Edinburgh, 2009).
- Liel, Helen P., 'Enlightened Bureaucracy versus Enlightened Despotism in Baden, 1750–1792'. *Transactions of the American Philosophical Society*, New Series vol. 55 no. 5 (1965): 1–132.
- Ligneron, Louis, 'Remembrements aux XVII^{ème} et XVIII^{ème} siècles'. *Mémoires de la Société pour l'histoire du droit et des institutions des anciens pays bourguignons, comtois, et romands* vol. 33 (1975–76): 291–301.
- Lindenfeld, David F., *The Practical Imagination: The German Sciences of State in the Nineteenth Century* (Chicago and London, 1997).
- Link, Edith M., *The Emancipation of the Austrian Peasant, 1740–1798* (New York, 1949).
- Lockhart, Douglas G. 'Lotted Lands and Planned Villages in North-East Scotland'. *The Agricultural History Review* vol. 49 no. 1 (2001): 17–40.
- Luna, Pablo F., 'La Catalogne de Ponz, de Young et de Zamora: l'utopie agropastorale et du travail, dans le dernier tiers du XVIII^e siècle'. *e-Spania revue interdisciplinaire d'études hispaniques médiévales et modernes* vol. 14 (December 2012), <http://e-spania.revues.org/21936?lang=en>, accessed 5 July 2015.
- Maat, Harro, *Science Cultivating Practice: A History of Agricultural Science in the Netherlands and its Colonies, 1863–1986* (Dordrecht, 2001).
- Macdonald, Stuart, 'The Diffusion of Knowledge among Northumberland Farmers, 1780–1815'. *The Agricultural History Review* vol. 27 no 1 (1979): 30–9.
- Macdonald, Stuart, 'Agricultural Improvement and the Neglected Labourer'. *The Agricultural History Review* vol. 31 (1983): 81–90.
- Maillard, Brigitte, *Les Campagnes de Touraine au XVIII^e siècle: structures agraires et économie rurale* (Rennes, 1998).
- Magnusson, Lars, *An Economic History of Sweden* (London and New York, 2000).
- Malanima, Paolo, *Pre-Modern European Economy: One Thousand Years (10th–19th Centuries)* (Leiden, 2009).
- Mantel, René, 'La Rochefoucauld-Liancourt: un novateur français dans la pratique agricole du XVIII^e siècle'. In *Etudes d'histoire économique rurale au XVIII^e siècle*, edited by Albert Rigaudière, Evelyne Zylberman, and René Mantel (Paris, 1965), pp. 151–204.
- Marache, Corinne, 'Bugeaud: un stratège aux champs'. In *Les Elites et la terre du XVI^e siècle aux années 1930*, edited by Caroline Le Mao and Corinne Marache (Paris, 2010), pp. 199–209.
- Marchand, Jean (ed.), *Voyages en France de François de La Rochefoucauld (1781–1783)*. 2 vols. (Paris, 1933–38).
- Marfany, Julie, *Land, Proto-Industry and Population in Catalonia, c.1680–1829: An Alternative Transition to Capitalism?* (Farnham, 2012).
- Margairaz, Dominique, *François de Neufchâteau: biographie intellectuelle* (Paris, 2005).
- Marti, Donald B., 'The Purposes of Agricultural Education: Ideas and Projects in New York State, 1819–1865'. *Agricultural History* vol. 45 no. 4 (1971): 271–83.

- Martin, Alison E. 'Pæns to Progress: Arthur Young's Travel Accounts in German Translation'. In *Cultural Transfer through Translation: The Circulation of Enlightened Thought in Europe by Means of Translation*, edited by Stefanie Stockhorst (Amsterdam and New York, 2010), pp. 297–314.
- Matthies, Jörg, 'Oest, Bechstedt und Hirschfeld: Drei Schöpfer einer neuen Kulturlandschaft im 18. Jahrhundert'. In *Die Ordnung der Natur: Vorträge zu historischen Gärten und Parks in Schleswig-Holstein* edited by Rainer Hering (Hamburg, 2009), pp. 71–94, <http://hup.sub.uni-hamburg.de>, accessed 20 March 2015.
- Maurin, Y., 'Hofwyl vue par les agronomes français: philanthropie ou école d'agriculture modèle?' *Annales d'histoire des enseignements agricoles* vols 4–5 (1992): 23–9.
- McCall, A. G., 'The Development of Soil Science'. *Agricultural History* vol. 5 no. 2 (1931): 43–56.
- McCosh, Frank W. J., *Boussingault: Chemist and Agriculturist* (Dordrecht and Boston, 1984).
- McKie, Douglas, *Antoine Lavoisier, Scientist, Economist, Social Reformer* (London, 1952).
- McMurry, Sally, 'Who Read Agricultural Journals? Evidence from Chenango County, New York, 1839–1865'. *Agricultural History* vol. 63 no. 4 (1989): 1–18.
- Meek, Ronald L., *The Economics of Physiocracy: Essays and Translations* (London, 1962).
- Meijers, Anthonie (ed.), *Philosophy of Technology and Engineering Sciences* (Amsterdam, 2009).
- Merriman, John M. 'The "Demoiselles" of the Ariège, 1829–1831'. In *1830 in France*, edited by John M. Merriman (New York, 1975), pp. 87–118.
- Mertens, Joost, 'Technology as the Science of the Industrial Arts: Louis-Sébastien Lenormand (1757–1837) and the Popularization of Technology'. *History and Technology* vol. 18 no. 2 (September 2002): 203–31.
- Mitchison, Rosalind, 'The Old Board of Agriculture (1793–1822)', *English Historical Review* vol. 74, no. 290 (1959): 41–79.
- Mitchison, Rosalind, *Agricultural Sir John: The Life of Sir John Sinclair of Ulbster, 1754–1835* (London, 1962).
- Mokyr, Joel, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton, NJ, 2002).
- Mokyr, Joel, *The Enlightened Economy: An Economic History of Britain, 1750–1850* (New Haven, CT, 2009).
- Moody, Theodore T. and Vaughan, William E., *A New History of Ireland*, vol. 5: *Ireland under the Union, I, 1801–70* (Oxford, 1989).
- Moriceau, Jean-Marc, and Postel-Vinay, Gilles, *Ferme, entreprise, famille: grande exploitation et changements agricoles: les Chartier, XVII^e–XIX^e siècles* (Paris, 1992).
- Morineau, Michel, *Les faux-semblants d'un démarrage économique: agriculture et démographie en France au XVIII^e siècle*, Cahier des Annales 30 (Paris, 1971).
- Moullier, Igor, 'Un territoire comme les autres? Les départements belges et la politique industrielle napoléonienne, 1799–1814'. In *La Gloire de l'industrie, XVII^e–XIX^e siècle. Faire l'histoire avec Gérard Gayot*, edited by Corinne Maitte, Philippe Minard, and Matthieu de Oliveira (Rennes, 2012), pp. 171–86.
- Müller, Hans H., 'Christopher Brown—an English Farmer in Brandenburg-Prussia in the Eighteenth Century'. *The Agricultural History Review* vol. 17 no. 2 (1969): 120–35.
- Munck, Thomas, 'The Danish Reformers'. In *Enlightened Absolutism: Reform and Reformers in later Eighteenth-Century Europe*, edited by Hamish H. Scott (Basingstoke, 1990), pp. 245–63.

- Munck, Thomas, 'Absolute Monarchy in Later Eighteenth-Century Denmark: Centralised Reform, Public Expectations and the Copenhagen Press'. *The Historical Journal* vol. 41 no. 1 (1998): 201–24.
- Munck, Thomas, 'Literacy, Educational Reform and the Use of Print in Eighteenth-Century Denmark'. *European History Quarterly* vol. 34 no. 3 (2004): 275–303.
- Munday, Pat, 'Liebig's Metamorphosis: From Organic Chemistry to the Chemistry of Agriculture'. *Ambix* vol. 38 no. 3 (November 1991): 135–54.
- Myrdal, Janken 'Agricultural Literature in Scandinavia and Anglo-Saxon Countries, c. 1700–1800 as an Indicator of a Changed Mentality', <http://www.kuleuven.be/icag/files/MyrdalLeuvenw2014.pdf>, accessed 15 March 2015.
- Myrdal, Janken and Morell, Mats (eds), *The Agrarian History of Sweden: 4000 BC to AD 2000* (Lund, 2011).
- Nilsson, Anders, Pettersson, Lars, and Svensson, Patrick, 'Agrarian Transition and Literacy: The Case of Nineteenth-Century Sweden'. *European Review of Economic History* vol. 3 no. 1 (1999): 49–72.
- North, Michael, *'Material Delight and the Joy of Living': Cultural Consumption in the Age of Enlightenment in Germany* (Farnham, 2008).
- Norton Wise, Matthew (ed.), *The Values of Precision* (Princeton, NJ, 1995).
- Nowotny, Peter, *Vereinödung im Allgäu und in den angrenzenden Gebieten* (Kempten, 1984).
- O'Malley, Therese, and Volschke-Bulmahn, Joachim (eds), *John Evelyn's 'Elysium Britannicum' and European Gardening*. Published by Dumbarton Oaks Research Library and Collection Washington, DC as vol. 17 in the series Dumbarton Oaks Colloquium on the History of Landscape Architecture (Dumbarton Oaks, 1998).
- O'Rourke, Kevin H., 'Late 19th Century Denmark in an Irish Mirror: Land Tenure, Homogeneity and the Roots of Danish Success', <http://www.tcd.ie/Economics/staff/orourke>, accessed 29 May 2014.
- Ogilvie, Sheilagh (ed.), *Germany: A New Social and Economic History*, vol. 2: 1630–1800 (London, 1996).
- Ogilvie, Sheilagh, *State Corporatism and Proto-Industry: The Württemberg Black Forest, 1580–1797* (Cambridge, 1997).
- Oittinen, Vesa K., 'Between Radicalism and Utilitarianism: On the Profile of the Finnish Enlightenment'. In *The Philosophical Age. Almanac. Issue 36: The Northern Lights: Facets of the Enlightenment Culture*, edited by Tatiana Artemyeva, Vesa Kalevi Oittinen, and Mikhail Mikeshein (St Petersburg and Helsinki, 2010), pp. 10–24.
- Orwin, Christabel S. and Orwin, Charles S., *The Open Fields*. 3rd edn. (Oxford, 1967).
- Orwin, Christabel S. and Whetham, Edith H., *A History of British Agriculture, 1846–1914* (London, 1964).
- Overton, Mark, 'The Determinants of Crop Yields in Early Modern England'. In *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity*, edited by Bruce M. S. Campbell and Mark Overton (Manchester, 1991), pp. 284–322.
- Overton, Mark, *Agricultural Revolution in England: The Transformation of the Agrarian Economy, 1500–1850* (Cambridge, 1996).
- Pannabecker, John R. 'Inventing Industrial Education: The *Ecole d'Arts et Métiers* of Châlons-sur-Marne, 1807–1830'. *History of Education Quarterly* vol. 44 no. 2 (2004): 222–49.
- Parry, Martin L. and Slater, Terry R., *The Making of the Scottish Countryside* (London, 1980).
- Pazzagli, Rossano, 'From Private Initiative to State Intervention: The Origins of Agricultural Education in Italy'. In *The State and Rural Societies: Policy and Education in Europe, 1750–2000*, edited by Nadine Vivier (Turnhout, 2008), pp. 231–46.

- Pawson, Henry C., *Robert Bakewell Pioneer Livestock Breeder* (London, 1957).
- Peltre, Jean, 'Du XVI^e au XVIII^e siècle: une génération de nouveaux villages en Lorraine'. *Revue géographique de l'Est* vol. 1–2 (1966): 2–27.
- Peltre, Jean, *Recherches métrologiques sur les finages lorrains* (Lille and Paris, 1977).
- Persson, Christer, 'Freehold Farmers and Land Ownership Structure in a Parish of South-Eastern Sweden during the Nineteenth Century'. *Journal of Historical Geography* vol. 14 no. 3 (1988): 245–59.
- Persson, Karl G., *An Economic History of Europe: Knowledge, Institutions and Growth, 600 to the Present* (Cambridge, 2010).
- Phillips, A. D. M., *The Underdraining of Farmland in England during the Nineteenth Century* (Cambridge, 1989).
- Picon, Antoine, 'Towards a History of Technological Thought'. In *Technological Change: Methods and Themes in the History of Technology*, edited by Robert Fox (Amsterdam, 1996), pp. 37–49.
- Pitte, Jean-Robert, 'Les Origines et l'évolution de la châtaigneraie vivaraise à travers un document cadastral du XVIII^e siècle'. *Comité des travaux historiques et scientifiques, Bulletin de la section de géographie* vol. 82 (1975–77): 165–78.
- Pollard, Sidney, *Peaceful Conquest: The Industrialization of Europe, 1760–1970* (Oxford, 1981).
- Pomeranz, Kenneth, *The Great Divergence: Europe, China and the Making of the Modern World Economy* (Princeton, NJ, 2000).
- Pomeranz, Kenneth, 'Ten Years After: Responses and Reconsiderations'. *Historically Speaking* vol. 12 no. 4 (2011): 20–5.
- Poplow, Marcus, 'Knowledge Management to Exploit Agrarian Resources as Part of Late Eighteenth-Century Cultures of Innovation: Friedrich Casimir Medicus and Franz von Paula Schrank'. *Annals of Science* vol. 69 no. 3 (2012): 413–33.
- Porskrog Rasmussen, Carsten, 'Innovative Feudalism: the Development of Dairy Farming and Koppelwirtschaft on Manors in Schleswig-Holstein in the Seventeenth and Eighteenth Centuries'. *The Agricultural History Review* vol. 58 no. 2 (December 2010): 172–90.
- Porter, Theodore, *The Rise of Statistical Thinking, 1820–1900* (Princeton, NJ, 1986).
- Post John D., *The Last Great Subsistence Crisis in the Western World* (Baltimore and London, 1977).
- Postel-Vinay, Gilles and Aymard, Maurice, 'La Perception française de l'agriculture et de l'agronomie italiennes dans la première moitié du XIX^e siècle'. In *Fra Studio, politica ed economia: la Società Agraria dalle origini all'età giolittiana. Atti de 6° Convegno. Bologna, 13–15 dicembre 1990*, edited by Roberto Finzi (Bologna, 1992), pp. 575–96.
- Prange, Wolfgang, *Die Anfänge der grossen Agrarreformen in Schleswig-Holstein bis 1771* (Neumünster, 1971).
- Prass, Reiner, *Reformprogramm und Bäuerliche Interessen: die Auflösung der traditionellen Gemeindeökonomie im südlichen Niedersachsen, 1750–1883* (Göttingen, 1997).
- Pred, Allan R., *Place, Practice and Structure: Social and Spatial Transformation in Southern Sweden, 1750–1850* (Oxford, 1986).
- Prescott, James A., 'The Russian Free Economic Society: Foundation Years'. *Agricultural History* vol. 51 no. 3 (1977): 503–12.
- Prévot, Pierre, 'Gaston de Spandl (1775–1836): maître de fosses—régisseur financier du baron Philippe de Néverlée Baulet', <http://www.fleurusouvenirs.be>, accessed 4 July 2015.
- Price, Mary Bell and Price, Lawrence Marsden, *The Publication of English Literature in Germany in the Eighteenth Century* (Berkeley, CA, 1934).
- Prothero, R. E. [Lord Ernle], *English Farming Past and Present* (London, 1912).

- Quellier, Florent, *Des Fruits et des hommes: l'arboriculture en Ile-de-France vers 1600-vers 1800* (Rennes, 2003).
- Quellier, Florent and Provost, Georges (eds), *Du Ciel à la terre: clergé et agriculture, XVI^e-XIX^e siècle* (Rennes, 2008).
- Raj, Kapil, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650-1900* (Basingstoke, 2007).
- Rao, Anna M., 'The Feudal Question, Judicial Systems and the Enlightenment'. In *Naples in the Eighteenth Century: The Birth and Death of a Nation-State*, edited by Girolamo Imbruglia (Cambridge, 2000), pp. 95-117.
- Reinert, Sophus, *Translating Empire: Emulation and the Origins of Political Economy* (Cambridge, MA, 2011).
- Reinert, Sophus A., 'Patriotism, Cosmopolitanism and Political Economy in the *Accademia dei pugni* in Lombardy, 1760-1780'. In *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, edited by Koen Stapelbroek and Jani Marjanen (London, 2012), pp. 130-56.
- Reitel, François, 'A Propos de l'openfield lorrain'. *Revue géographique de l'Est* vol. 6 (1966): 21-52.
- Renes, Hans, 'Grainlands: The Landscape of Open Fields in a European Perspective'. *Landscape History* vol. 31 no. 2 (2010): 37-70.
- Reynaud, Florian, *L'Élevage bovin: de l'agronome au paysan, 1700-1850* (Rennes, 2010).
- Rise Hansen, Carl and Steenberg, Axel, *Jordfordeling og Udsiftning: Undersøgelser I tre Sjællandske Landsbyer* (Copenhagen, 1951).
- Robertson, John, *The Case for the Enlightenment: Scotland and Naples, 1680-1760* (Cambridge, 2005).
- Robin, Paul, Aeschlimann, Jean-Pierre, and Feller, Christian (eds), *Histoire et agronomie: entre ruptures et durée* (Paris, 2007).
- Robisheaux, Thomas, *Rural Society and the Search for Order in Early Modern Germany* (Cambridge, 1989).
- Rosenthal, Jean-Laurent, *The Fruits of Revolution: Property Rights, Litigation and French Agriculture* (Cambridge, 1992).
- Rossiter, Margaret W., *The Emergence of Agricultural Science* (New Haven, CT, 1975).
- Rural History 2013 (First Conference of the European Rural History Organisation [EURHO])*, University of Berne, 19-21 August 2013.
- Russell, E. John, 'Rothamsted and its Experiment Station'. *Agricultural History* vol. 16 no. 4 (October 1942): 161-83.
- Russell, Sir E. John, *A History of Agricultural Science in Great Britain, 1620-1954* (London, 1966).
- Rydén, Gören, 'The Enlightenment in Practice: Swedish Travellers and Knowledge about the Metal Trades'. In *Sweden in the Eighteenth-Century World: Provincial Cosmopolitans*, edited by Gören Rydén (Farnham, 2013), pp. 63-86.
- Rydén, Göran (ed.), *Sweden in the Eighteenth-Century World: Provincial Cosmopolitans* (Farnham, 2013).
- Saboulin-Bollena, Roger de, 'Les Forêts de la Lozère'. *Forêt méditerranéenne* vol. 5 no. 1 (1983): 3-44.
- Saint-Jacob, Pierre de, *Les Paysans de la Bourgogne du Nord au dernier siècle de l'Ancien Régime* (Dijon, 1960).
- Santiago-Caballero, Carlos, 'Provincial Grain Yields in Spain 1750-2009'. *Working Papers in Economic History*, (May 2012), Universidad Carlos III de Madrid, <http://www.uc3m.es>, accessed 16 July 2015.

- Santiago-Caballero, Carlos, 'Trapped by Nature: Provincial Grain Yields in Spain in the Mid-18th Century'. *Revista de Historia Económica/Journal of Iberian and Latin American Economic History* (January 2015): 1–28. doi 10.1017/S0212610913000165.
- Scarfe, Norman, *A Frenchman's Year in Suffolk: French Impressions of Suffolk Life in 1784 including a preliminary week in London, brief visits to Cambridge, Colchester, Mistley and Harwich and a fortnight's tour of Norfolk*. Translated and edited by Norman Scarfe (Woodbridge, 1988).
- Scarfe, Norman, *Innocent Espionage: The La Rochefoucauld Brothers' Tour of England in 1785* (Woodbridge, 1995).
- Scarfe, Norman, *To the Highlands in 1786: The Inquisitive Journey of a Young French Aristocrat* (Woodbridge, 2001).
- Schmidt Uwe E., *Der Wald in Deutschland im 18. und 19. Jahrhundert. Das Problem der Ressourcenknappheit dargestellt am Beispiel der Waldressourcenknappheit im 18. und 19. Jahrhundert: eine historische-politische Analyse* (Saarbrücken, 2002).
- Schumpeter, Joseph, 'Die Crise des Steuerstaates [1918]' translated as 'The Crisis of the Tax State'. In *International Economic Papers: Translations Prepared for the International Economic Association*, edited by Alan T. Peacock, Wolfgang F. Stolper et al. no. 4 (London and New York, 1954), pp. 5–38.
- Schwartz, Robert M., 'The Noble Profession of Seigneur in Eighteenth-Century Burgundy'. In *The French Nobility in the Eighteenth Century: Reassessments and New Approaches*, edited by Jay M. Smith (University Park, PA, 2006), pp. 91–107.
- Scott, Hamish H., *Enlightened Absolutism: Reform and Reformers in Later Eighteenth-Century Europe* (Basingstoke, 1990).
- Serrano, Elena, 'Making Oeconomic People: the Spanish *Magazine of Agriculture and Arts for Parish Rectors* (1797–1808)'. *History and Technology* vol. 30 no. 3 (2014): 149–76.
- Shovlin, John, 'Emulation in Eighteenth-Century French Economic Thought'. *Eighteenth-Century Studies* vol. 36 no. 2 (2003): 224–30. doi 10.1353/ecs.2003.0021.
- Shovlin, John, 'Political Economy and the French Nobility, 1750–1789'. In *The French Nobility in the Eighteenth Century: Reassessments and New Approaches*, edited by Jay M. Smith (University Park, PA, 2006), pp. 111–38.
- Simpson, James, *Spanish Agriculture: The Long Siesta, 1765–1965* (Cambridge, 1995).
- Singer, Charles, Holmyard, Eric J., and Hall, Alfred, R., *A History of Technology*. 5 vols. (London, 1954–58).
- Skrubbeltrang, Fridlev, *Agricultural Development and Rural Reform in Denmark* (Rome, 1953).
- Slicher van Bath, B. H., *The Agrarian History of Western Europe AD 500–1850* (London, 1963).
- Smeaton, William A., 'Lavoisier's Membership of the Société Royale d'Agriculture and the Comité d'Agriculture'. *Annals of Science* vol. 12 (1956): 267–77.
- Smith, Jay M. (ed.), *The French Nobility in the Eighteenth Century: Reassessments and New Approaches* (University Park, PA, 2006).
- Smout, T. Chris, *A History of the Scottish People* (London, 1969, 1985).
- Smout, T. Chris, 'A New Look at the Scottish Improvers'. *Scottish Historical Review* vol. 91 no. 1 (2012): 125–49.
- Solar, Peter and Goossens, Martine, 'Agricultural Productivity in Belgium and Ireland in the Early Nineteenth Century'. In *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity*, edited by Bruce M. S. Campbell and Mark Overton (Manchester, 1991), pp. 364–84.
- Spary, Emma C., *Feeding France: New Sciences of Food, 1760–1815* (Cambridge, 2014).

- Stapelbroek, Koen and Marjanen, Jani (eds), *The Rise of the Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America* (London, 2012).
- Stockhorst, Stefanie (ed.), *Cultural Transfer through Translation: The Circulation of Enlightened Thought in Europe by Means of Translation* (Amsterdam and New York, 2010).
- Stone, Richard, *Some British Empiricists in the Social Sciences, 1650–1900* (Cambridge, 1997).
- Stuber, Martin, 'Die Oekonomische Gesellschaft Bern als Kontaktzone im europäischen Austausch agrarisch-ökonomischen Wissens', *Discussions*, 7 (2012): 20–2, <http://www.perspectivia.net>, accessed 16 July 2015.
- Sundberg, Kerstin, Germundsson, Tomas, and Hansen, Kjell (eds), *Modernisation and Tradition: European Local and Manorial Societies* (Lund, 2004).
- Svensson, Henrik, *Öppna och slutna rum—enskiftet och de utsatta geografi: husmän, bönder och gods på den Skånska landsbygden under 1800-talets första hälft/Open and Closed Spaces—Enclosure and the Geography of the Exposed: Cottagers, Peasants and Estates in the Scanian Countryside during the First Half of the Nineteenth Century* (Institutionen för kulturgeografi och ekonomisk geografi, Lund University, 2005).
- Terlinden, Charles, 'La Politique économique de Guillaume I^{er}, Roi des Pays-Bas en Belgique, 1814–1830'. *Revue historique* vol. 89 (1922): 1–39.
- Théré, Christine, 'Economic Publishing and Authors, 1566–1789', *Studies in the History of French Political Economy: From Bodin to Walras*, edited by Gilbert Faccarello (New York, 1998): 1–56.
- Théron de Montaugé, Louis, *L'Agriculture et les classes rurales dans le pays toulousain depuis le milieu du dix-huitième siècle* (Toulouse, 1869).
- Thirsk, Joan, 'The World-Wide Farming Web, 1500–1800'. In *A Common Agricultural Heritage? Revising French and British Rural Divergence*, edited by John Broad (*Agricultural History Review* Supplement, 2009), pp. 13–22.
- Toen, Erik, 'A "Commercial Survival Economy" in Evolution: The Flemish Countryside and the Transition to Capitalism (Middle Ages–19th Century)'. In *Peasants into Farmers? The Transformation of Rural Economy and Society in the Low Countries (Middle Ages–19th Century)*, edited by Peter Hoppenbrouwers and Jan Luiten van Zanden (Turnhout, 2001), pp. 102–57.
- Thorpe, Harry, 'The Influence of Inclosure on the Form and Pattern of Rural Settlement in Denmark'. *Transactions and Papers (Institute of British Geographers)* vol. 17 (1951): 113–29.
- Thorpe, Harry, 'A Special Case of Heath Reclamation in the Alheden District of Jutland, 1700–1955'. *Transactions and Papers (Institute of British Geographers)* vol. 23 (1957): 87–121.
- Tracy, Michael, *Government and Agriculture in Western Europe*. 3rd edn. (Hemel Hempstead, 1989).
- Tremblay, Jacques (ed.), *Les Savants genevois dans l'Europe intellectuelle du XVII^e au milieu du XIX^e siècle* (Geneva, 1987).
- Tresse, René, 'Le Développement de la fabrication des faux en France de 1786 à 1827 et ses conséquences sur la pratique des moissons'. *Annales, économies, sociétés, civilisations* vol. 2 no. 3 (1955): 341–58.
- Tribe, Keith, *The Economy of the World: Language, History, and Economics* (Oxford, 2015).
- Turner, Michael E., 'Sitting on the Fence of Parliamentary Enclosure: A Regressive Social Tax with Problematic Efficiency Gains' In *Agricultural History: Papers Presented to the Economic History Society Conference, at Canterbury, Saturday 9 April 1983*, edited by Mark Overton, E. J. T. Collins, Michael E. Turner, and Donald N. McCloskey (Economic History Society, Canterbury, 1983), pp. 19–35.
- Turner, Michael E., *After the Famine: Irish Agriculture, 1850–1914* (Cambridge, 1996).

- Unwin, M. Joan and Unwin, Marion E., 'An Edge of Steel'. In *L'Acier en Europe avant Bessemer*, edited by Philippe Dilmann, Liliane Pérez, and Catherine Verna (Toulouse, 2011), pp. 111–27.
- Vardi, Liana, *The Physiocrats and the World of the Enlightenment* (Cambridge, 2012).
- Vernus, Michel, 'La Diffusion du Progrès agricole en Franche-Comté de 1760 à 1889'. In *Les Enjeux de la formation des acteurs de l'agriculture, 1760–1945*, edited by Michel Boulet (Dijon, 2000), pp. 275–80.
- Vilar, Pierre, *La Catalogne dans l'Espagne moderne: recherches sur les fondements économiques des structures nationales*. 3 vols. (Paris, 1962).
- Vivier, Nadine (ed.), *The State and Rural Societies: Policy and Education in Europe, 1750–2000* (Turnhout, 2008).
- Vivier, Nadine (ed.), *Elites et progrès agricoles, XVI^e–XX^e siècle* (Rennes, 2009).
- Vries, P. H. H., 'Are Coal and Colonies really Crucial? Kenneth Pomeranz and the Great Divergence'. *Journal of World History* vol. 12 no. 2 (2001): 407–46. doi 10.1353/jwh.2001.0046.
- Wade-Martins, Susanna, 'The English Model Farm 1700–1900: Significance and Context'. *Journal of the Historic Farm Buildings Group* vol. 11 (1997): 17–54.
- Wakefield, André, *The Disordered Police State: German Cameralism as Science and Practice* (Chicago, 2009).
- Warde, Paul, *Ecology, Economy and State Formation in Early Modern Germany* (Cambridge, 2006).
- Watts, Ian P., '"We Want No Authors": William Nicholson and the Contested Role of the Scientific Journal in Britain, 1797–1813'. *The British Journal for the History of Science* vol. 47 no. 3 (2014): 397–419.
- Weiss, John H., *The Making of Technological Man: The Social Origins of French Engineering Education* (Cambridge, MA, 1982).
- Weitzman, Martin L., 'Recombinant Growth'. *Quarterly Journal of Economics* vol. 113 (1998): 331–60.
- Weulersse, Georges, *La Physiocratie à l'aube de la Révolution* (Paris, 1995).
- Wilkes, A. R., 'Adjustments in Arable Farming after the Napoleonic Wars'. *The Agricultural History Review* vol. 28 no. 2 (1980): 90–103.
- Williams, Michael, 'The Enclosure and Reclamation of Waste Land in England and Wales in the Eighteenth and Nineteenth Centuries'. *Transactions of the Institute of British Geographers* vol. 51 (November 1970): 55–69.
- Williams, Roger L., *Botanophilia in Eighteenth-Century France: The Spirit of the Enlightenment* (Dordrecht, 2001).
- Williamson, Jeffrey G., 'The Impact of the Corn Laws just prior to Repeal'. *Explorations in Economic History* vol. 27 (1990): 123–56.
- Windfeld Lund, Niels, 'Kartoffeltyskerne: Livsvilkår i de jyske hedekolonier i det 18 årh. / The Potato Germans: Living Conditions in the Jutland Heath Colonies in the 18th Century'. *Folk og Kultur* (1975): 31–66.
- Withers, Charles, W. J., 'William Cullen's Agricultural Lectures and Writings and the Development of Agricultural Science in Eighteenth-Century Scotland'. *The Agricultural History Review* vol. 37 no. 2 (1989): 144–56.
- Wright, William E., *Serf, Seigneur and Sovereign: Agrarian Reform in Eighteenth-Century Bohemia* (Minneapolis, 1966).
- Wrigley, Anthony E., 'Urban Growth and Agricultural Change: England and the Continent in the Early Modern Period'. *Journal of Interdisciplinary History* vol. 15 no. 4 (1985): 683–728.

- Wunder, Heide, 'Agriculture and Agrarian Society'. In *Germany: A New Social and Economic History*, vol 2: 1630–1800, edited by Sheilagh Ogilvie (London, 1996), pp. 63–99.
- Wykes, David L., 'Robert Bakewell (1725–1795) of Dishley: Farmer and Livestock Improver'. *The Agricultural History Review* vol. 52 (2004): 38–55.
- Zanden, Jan Luiten van, *The Transformation of European Agriculture in the Nineteenth Century: The Case of the Netherlands* (Amsterdam, 1994).
- Zanden, Jan Luiten van, *The Long Road to the Industrial Revolution: The European Economy in a Global Perspective, 1000–1800* (Leiden, 2009).
- Zylberman, E., 'Augé de Montyon et l'agriculture'. In *Etudes d'histoire économique rurale au XVIII^e siècle*, edited by Albert Rigaudière, Evelyne Zylberman, and René Mantel (Paris, 1965), pp. 105–50.

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